

## ANTISENSE MODULATION OF KINESIN-LIKE 1 EXPRESSION

[0001] This application is a continuation-in-part of U.S. Patent Application Serial No.10/156,603, filed on May 23, 2002, the contents of which are incorporated herein in their entirety.

### FIELD OF THE INVENTION

[0002] The present invention provides compositions and methods for modulating the expression of kinesin-like 1. In particular, this invention relates to compounds, particularly oligonucleotides, specifically hybridizable with nucleic acids encoding kinesin-like 1. Such compounds have been shown to modulate the expression of kinesin-like 1.

### BACKGROUND OF THE INVENTION

[0003] The intracellular transport of proteins, lipids, and mRNA to specific locations within the cell, as well as the proper alignment and separation of chromosomes in dividing cells, is essential to the functioning of the cell. The superfamily of proteins called kinesins (KIF), along with the myosins and dyneins, function as molecular engines to bind and transport vesicles and organelles along microtubules with energy supplied by ATP. KIFs have been identified in many species ranging from yeast to humans. The amino acid sequences which comprise the motor domain are highly conserved among eukaryotic phyla, while the region outside of the motor domain serves to bind to the cargo and varies in amino acid sequence among KIFs. The movement of a kinesin along a microtubule can occur in either the plus or minus direction, but any given kinesin can only travel in one direction, an action that is mediated by the polarity of the motor and the microtubule. The KIFs have been grouped into three major types depending on the position of the motor domain: the amino-terminal domain, the middle motor domain, and the carboxyl-terminal domain, referred to respectively as N-kinesin, M-kinesin, and C-kinesins. These are further

classified into 14 classes based on a phylogenetic analysis of the 45 known human and mouse kinesin genes (Miki et al., *Proc. Natl. Acad. Sci. U. S. A.*, **2001**, 98, 7004-7011).

[0004] One such kinesin, kinesin-like 1, a member of the N-2 (also called bimC) family of kinesins and is involved in separating the chromosomes by directing their movement along microtubules in the bipolar spindle. During mitosis, the microtubule bipolar spindle functions to distribute the duplicated chromosomes equally to daughter cells. Kinesin-like 1 is first phosphorylated by the kinase p34<sup>cdc2</sup> and is essential for centrosome separation and assembly of bipolar spindles at prophase (Blangy et al., *Cell*, **1995**, 83, 1159-1169). In rodent neurons, kinesin-like 1 is expressed well past their terminal mitotic division, and has been implicated in regulating microtubule behaviors within the developing axons and dendrites (Ferhat et al., *J. Neurosci.*, **1998**, 18, 7822-7835). The gene encoding human kinesin-like 1 (also called KNSL1, Eg5, HsEg5, HKSP, KIF11, thyroid interacting protein 5, and TRIP5) was cloned in 1995 (Blangy et al., *Cell*, **1995**, 83, 1159-1169).

[0005] Inhibition of kinesin-like 1 has been suggested as a target for arresting cellular proliferation in cancer because of the central role kinesin-like 1 holds in mitosis. Expression of kinesin-like 1 may also contribute to other disease states. A contribution of kinesin-like 1 to B-cell leukemia has been demonstrated in mice as a result of upregulated expression of kinesin-like 1 following a retroviral insertion mutation in the proximity of the kinesin-like 1 gene (Hansen and Justice, *Oncogene*, **1999**, 18, 6531-6539). Autoantibodies to a set of proteins in the mitotic spindle assembly have been detected in human sera and these autoantibodies have been associated with autoimmune diseases including carpal tunnel syndrome, Raynaud's phenomenon, systemic sclerosis, Sjorgren's syndrome, rheumatoid arthritis, polymyositis, and polyarteritis. One of these autoantigens is kinesin-like 1 and has been identified in systemic lupus erythematosus (Whitehead et al., *Arthritis Rheum.*, **1996**, 39, 1635-1642).

[0006] Currently, there are no known therapeutic agents which effectively inhibit the synthesis of kinesin-like 1. The use of antibodies to kinesin-like 1 has been reported several times in the art as a method to examine the participation of kinesin-like 1 during different stages of mitosis (Blangy et al., *Cell*, **1995**, 83, 1159-1169.; Kapoor et al., *J. Cell Biol.*, **2000**, 150, 975-988.; Whitehead and Rattner, *J. Cell Sci.*, **1998**, 111, 2551-2561). For instance, in the presence of antibodies specific to kinesin-like 1, microtubule arrays responsible for pre- and post-mitotic centrosome movement never form, confirming the

recurring role of kinesin-like 1 in establishing the microtubule arrays that form during cell division. This role may also encompass the ability of kinesin-like 1 to influence the distribution of other protein components associated with cell division (Whitehead and Rattner, *J. Cell Sci.*, **1998**, *111*, 2551-2561).

[0007] The small molecule monastrol has been used *in vitro* as a useful and specific tool to probe the involvement of kinesin-like 1 in the mitotic process (Kapoor et al., *J. Cell Biol.*, **2000**, *150*, 975-988). Like the anti-kinesin-like 1 antibodies, the small molecule monastrol produces a monoastral phenotype, as opposed to the bipolar spindle, and subsequently arrests mitosis. The formation of the monastral spindle is reversible when monastrol is washed away, and the mechanism of monastrol action is presumed to be inhibition of kinesin-like 1 (Mayer et al., *Science*, **1999**, *286*, 971-974).

[0008] Another small molecule, all-trans-retinoic acid (ATRA) is able to arrest growth in a number of different cell types such as melanoma, lymphoma, neuroblastoma, embryonic stem, and carcinoma cells by modulating gene expression. Kinesin-like 1 is one of these target genes and the expression of kinesin-like 1 in pancreatic carcinoma cell lines is inhibited by ATRA at the posttranscriptional level. These anti-proliferative effects arising from ATRA inhibition of kinesin-like 1 was further confirmed by the use of an antisense expression vector directed against kinesin-like 1 (Kaiser et al., *J. Biol. Chem.*, **1999**, *274*, 18925-18931).

[0009] U.S. Patent Application Publication No. 2002/0165240, published November 7, 2002 (Kimball et al.), discloses methods for treating a condition via modulation of Eg5 protein activity comprising administering a small molecule Eg5 inhibitor.

[0010] There remains a long felt need for additional agents capable of effectively inhibiting kinesin-like 1 function.

[0011] Antisense technology is emerging as an effective means for reducing the expression of specific gene products and may therefore prove to be uniquely useful in a number of therapeutic, diagnostic, and research applications for the modulation of kinesin-like 1 expression. A small interfering RNA (siRNA) targeting the mRNA of the kinesin has been used to assay for the optimization of siRNA transfection, and was found to induce mitotic arrest. D. Weil et al., 2002, *BioTechniques* 33:1244-1248. U.S. Patent 6,472,521, issued October 29, 2002 (Uhlmann et al.), discloses and claims oligonucleotides for the

inhibition of human Eg5 expression. PCT Publication WO 03/030832, published April 17, 2003 (Reinhard et al.), discloses use of antisense oligonucleotides that target human kinesin genes for treating diseases involving aberrant cell proliferation. The kinesin gene may be human Eg5.

[0012] The present invention provides compositions and methods for modulating kinesin-like 1 expression.

## **SUMMARY OF THE INVENTION**

[0013] The present invention is directed to antisense compounds, especially nucleic acid and nucleic acid-like oligomers, which are targeted to a nucleic acid encoding kinesin-like 1, and which modulate the expression of kinesin-like 1. Pharmaceutical and other compositions comprising the compounds of the invention are also provided. Further provided are methods of screening for modulators of kinesin-like 1 and methods of modulating the expression of kinesin-like 1 in cells, tissues or animals comprising contacting said cells, tissues or animals with one or more of the compounds or compositions of the invention. Methods of treating an animal, particularly a human, suspected of having or being prone to a disease or condition associated with expression of kinesin-like 1 are also set forth herein. Such methods comprise administering a therapeutically or prophylactically effective amount of one or more of the compounds or compositions of the invention to the person in need of treatment.

## **DETAILED DESCRIPTION OF THE INVENTION**

### **A. Overview of the Invention**

[0014] The present invention employs antisense compounds, preferably oligonucleotides and similar species for use in modulating the function or effect of nucleic acid molecules encoding kinesin-like 1. This is accomplished by providing oligonucleotides which specifically hybridize with one or more nucleic acid molecules encoding kinesin-like 1. As used herein, the terms "target nucleic acid" and "nucleic acid molecule encoding kinesin-like 1" have been used for convenience to encompass DNA encoding kinesin-like 1, RNA (including pre-mRNA and mRNA or portions thereof) transcribed from such DNA, and also cDNA derived from such RNA. The hybridization of a compound of this invention with its target nucleic acid is generally referred to as

"antisense". Consequently, the preferred mechanism believed to be included in the practice of some preferred embodiments of the invention is referred to herein as "antisense inhibition." Such antisense inhibition is typically based upon hydrogen bonding-based hybridization of oligonucleotide strands or segments such that at least one strand or segment is cleaved, degraded, or otherwise rendered inoperable. In this regard, it is presently preferred to target specific nucleic acid molecules and their functions for such antisense inhibition.

[0015] The functions of DNA to be interfered with can include replication and transcription. Replication and transcription, for example, can be from an endogenous cellular template, a vector, a plasmid construct or otherwise. The functions of RNA to be interfered with can include functions such as translocation of the RNA to a site of protein translation, translocation of the RNA to sites within the cell which are distant from the site of RNA synthesis, translation of protein from the RNA, splicing of the RNA to yield one or more RNA species, and catalytic activity or complex formation involving the RNA which may be engaged in or facilitated by the RNA. One preferred result of such interference with target nucleic acid function is modulation of the expression of kinesin-like 1. In the context of the present invention, "modulation" and "modulation of expression" mean either an increase (stimulation) or a decrease (inhibition) in the amount or levels of a nucleic acid molecule encoding the gene, e.g., DNA or RNA. Inhibition is often the preferred form of modulation of expression and mRNA is often a preferred target nucleic acid.

[0016] In the context of this invention, "hybridization" means the pairing of complementary strands of oligomeric compounds. In the present invention, the preferred mechanism of pairing involves hydrogen bonding, which may be Watson-Crick, Hoogsteen or reversed Hoogsteen hydrogen bonding, between complementary nucleoside or nucleotide bases (nucleobases) of the strands of oligomeric compounds. For example, adenine and thymine are complementary nucleobases which pair through the formation of hydrogen bonds. Hybridization can occur under varying circumstances.

[0017] An antisense compound is specifically hybridizable when binding of the compound to the target nucleic acid interferes with the normal function of the target nucleic acid to cause a loss of activity, and there is a sufficient degree of complementarity to avoid non-specific binding of the antisense compound to non-target nucleic acid sequences under conditions in which specific binding is desired, i.e., under physiological conditions in the

case of *in vivo* assays or therapeutic treatment, and under conditions in which assays are performed in the case of *in vitro* assays.

[0018] In the present invention the phrase "stringent hybridization conditions" or "stringent conditions" refers to conditions under which a compound of the invention will hybridize to its target sequence, but to a minimal number of other sequences. Stringent conditions are sequence-dependent and will be different in different circumstances and in the context of this invention, "stringent conditions" under which oligomeric compounds hybridize to a target sequence are determined by the nature and composition of the oligomeric compounds and the assays in which they are being investigated.

[0019] "Complementary," as used herein, refers to the capacity for precise pairing between two nucleobases of an oligomeric compound. For example, if a nucleobase at a certain position of an oligonucleotide (an oligomeric compound), is capable of hydrogen bonding with a nucleobase at a certain position of a target nucleic acid, said target nucleic acid being a DNA, RNA, or oligonucleotide molecule, then the position of hydrogen bonding between the oligonucleotide and the target nucleic acid is considered to be a complementary position. The oligonucleotide and the further DNA, RNA, or oligonucleotide molecule are complementary to each other when a sufficient number of complementary positions in each molecule are occupied by nucleobases which can hydrogen bond with each other. Thus, "specifically hybridizable" and "complementary" are terms which are used to indicate a sufficient degree of precise pairing or complementarity over a sufficient number of nucleobases such that stable and specific binding occurs between the oligonucleotide and a target nucleic acid.

[0020] It is understood in the art that the sequence of an antisense compound need not be 100% complementary to that of its target nucleic acid to be specifically hybridizable. Moreover, an oligonucleotide may hybridize over one or more segments such that intervening or adjacent segments are not involved in the hybridization event (e.g., a loop structure or hairpin structure). It is preferred that the antisense compounds of the present invention comprise at least 70%, or at least 75%, or at least 80%, or at least 85% sequence complementarity to a target region within the target nucleic acid, more preferably that they comprise at least 90% sequence complementarity and even more preferably comprise at least 95% or at least 99% sequence complementarity to the target region within the target nucleic acid sequence to which they are targeted. For example, an antisense compound in

which 18 of 20 nucleobases of the antisense compound are complementary to a target region, and would therefore specifically hybridize, would represent 90 percent complementarity. In this example, the remaining noncomplementary nucleobases may be clustered or interspersed with complementary nucleobases and need not be contiguous to each other or to complementary nucleobases. As such, an antisense compound which is 18 nucleobases in length having 4 (four) noncomplementary nucleobases which are flanked by two regions of complete complementarity with the target nucleic acid would have 77.8% overall complementarity with the target nucleic acid and would thus fall within the scope of the present invention. Percent complementarity of an antisense compound with a region of a target nucleic acid can be determined routinely using BLAST programs (basic local alignment search tools) and PowerBLAST programs known in the art (Altschul et al., *J. Mol. Biol.*, **1990**, 215, 403-410; Zhang and Madden, *Genome Res.*, **1997**, 7, 649-656).

[0021] Percent homology, sequence identity or complementarity, can be determined by, for example, the Gap program (Wisconsin Sequence Analysis Package, Version 8 for Unix, Genetics Computer Group, University Research Park, Madison WI), using default settings, which uses the algorithm of Smith and Waterman (*Adv. Appl. Math.*, 1981, 2, 482-489). In some preferred embodiments, homology, sequence identity or complementarity, between the oligomeric and target is between about 50% to about 60%. In some embodiments, homology, sequence identity or complementarity, is between about 60% to about 70%. In preferred embodiments, homology, sequence identity or complementarity, is between about 70% and about 80%. In more preferred embodiments, homology, sequence identity or complementarity, is between about 80% and about 90%. In some preferred embodiments, homology, sequence identity or complementarity, is about 90%, about 92%, about 94%, about 95%, about 96%, about 97%, about 98%, about 99% or about 100%.

## **B. Compounds of the Invention**

[0022] According to the present invention, antisense compounds include antisense oligomeric compounds, antisense oligonucleotides, ribozymes, external guide sequence (EGS) oligonucleotides, alternate splicers, primers, probes, and other oligomeric compounds which hybridize to at least a portion of the target nucleic acid. As such, these compounds may be introduced in the form of single-stranded, double-stranded, circular or

hairpin oligomeric compounds and may contain structural elements such as internal or terminal bulges or loops. Once introduced to a system, the compounds of the invention may elicit the action of one or more enzymes or structural proteins to effect modification of the target nucleic acid.

[0023] One non-limiting example of such an enzyme is RNase H, a cellular endonuclease which cleaves the RNA strand of an RNA:DNA duplex. It is known in the art that single-stranded antisense compounds which are "DNA-like" elicit RNase H. Activation of RNase H, therefore, results in cleavage of the RNA target, thereby greatly enhancing the efficiency of oligonucleotide-mediated inhibition of gene expression. Similar roles have been postulated for other ribonucleases such as those in the RNase III and ribonuclease L family of enzymes.

[0024] While the preferred form of antisense compound is a single-stranded antisense oligonucleotide, in many species the introduction of double-stranded structures, such as double-stranded RNA (dsRNA) molecules, has been shown to induce potent and specific antisense-mediated reduction of the function of a gene or its associated gene products. This phenomenon occurs in both plants and animals and is believed to have an evolutionary connection to viral defense and transposon silencing.

[0025] The first evidence that dsRNA could lead to gene silencing in animals came in 1995 from work in the nematode, *Caenorhabditis elegans* (Guo and Kempheus, *Cell*, 1995, 81, 611-620). Montgomery et al. have shown that the primary interference effects of dsRNA are posttranscriptional (Montgomery et al., *Proc. Natl. Acad. Sci. USA*, 1998, 95, 15502-15507). The posttranscriptional antisense mechanism defined in *Caenorhabditis elegans* resulting from exposure to double-stranded RNA (dsRNA) has since been designated RNA interference (RNAi). This term has been generalized to mean antisense-mediated gene silencing involving the introduction of dsRNA leading to the sequence-specific reduction of endogenous targeted mRNA levels (Fire et al., *Nature*, 1998, 391, 806-811). Recently, it has been shown that it is, in fact, the single-stranded RNA oligomers of antisense polarity of the dsRNAs which are the potent inducers of RNAi (Tijsterman et al., *Science*, 2002, 295, 694-697).

[0026] The antisense compounds of the present invention also include modified compounds in which a different base is present at one or more of the nucleotide positions in the compound. For example, if the first nucleotide is an adenosine, modified compounds



may be produced which contain thymidine, guanosine or cytidine at this position. This may be done at any of the positions of the antisense compound. These compounds are then tested using the methods described herein to determine their ability to inhibit expression of kinesin-like 1 mRNA.

[0027] In the context of this invention, the term "oligomeric compound" refers to a polymer or oligomer comprising a plurality of monomeric units. In the context of this invention, the term "oligonucleotide" refers to an oligomer or polymer of ribonucleic acid (RNA) or deoxyribonucleic acid (DNA) or mimetics, chimeras, analogs and homologs thereof. This term includes oligonucleotides composed of naturally occurring nucleobases, sugars and covalent internucleoside (backbone) linkages as well as oligonucleotides having non-naturally occurring portions which function similarly. Such modified or substituted oligonucleotides are often preferred over native forms because of desirable properties such as, for example, enhanced cellular uptake, enhanced affinity for a target nucleic acid and increased stability in the presence of nucleases.

[0028] While oligonucleotides are a preferred form of the antisense compounds of this invention, the present invention comprehends other families of antisense compounds as well, including but not limited to oligonucleotide analogs and mimetics such as those described herein.

[0029] The antisense compounds in accordance with this invention preferably comprise from about 8 to about 80 nucleobases (i.e. from about 8 to about 80 linked nucleosides). One of ordinary skill in the art will appreciate that the invention embodies compounds of 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, or 80 nucleobases in length.

[0030] In one preferred embodiment, the antisense compounds of the invention are 12 to 50 nucleobases in length. One having ordinary skill in the art will appreciate that this embodies compounds of 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, or 50 nucleobases in length.

[0031] In another preferred embodiment, the antisense compounds of the invention are 15 to 30 nucleobases in length. One having ordinary skill in the art will appreciate that

this embodies compounds of 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, or 30 nucleobases in length.

[0032] Particularly preferred compounds are oligonucleotides from about 12 to about 50 nucleobases, even more preferably those comprising from about 15 to about 30 nucleobases.

[0033] Antisense compounds 8-80 nucleobases in length comprising a stretch of at least eight (8) consecutive nucleobases selected from within the illustrative antisense compounds are considered to be suitable antisense compounds as well.

[0034] Exemplary preferred antisense compounds include oligonucleotide sequences that comprise at least the 8 consecutive nucleobases from the 5'-terminus of one of the illustrative preferred antisense compounds (the remaining nucleobases being a consecutive stretch of the same oligonucleotide beginning immediately upstream of the 5'-terminus of the antisense compound which is specifically hybridizable to the target nucleic acid and continuing until the oligonucleotide contains about 8 to about 80 nucleobases). Similarly preferred antisense compounds are represented by oligonucleotide sequences that comprise at least the 8 consecutive nucleobases from the 3'-terminus of one of the illustrative preferred antisense compounds (the remaining nucleobases being a consecutive stretch of the same oligonucleotide beginning immediately downstream of the 3'-terminus of the antisense compound which is specifically hybridizable to the target nucleic acid and continuing until the oligonucleotide contains about 8 to about 80 nucleobases). It is also understood that preferred antisense compounds may be represented by oligonucleotide sequences that comprise at least 8 consecutive nucleobases from an internal portion of the sequence of an illustrative preferred antisense compound, and may extend in either or both directions until the oligonucleotide contains about 8 to about 80 nucleobases.

[0035] One having skill in the art armed with the preferred antisense compounds illustrated herein will be able, without undue experimentation, to identify further preferred antisense compounds.

### C. Targets of the Invention

[0036] "Targeting" an antisense compound to a particular nucleic acid molecule, in the context of this invention, can be a multistep process. The process usually begins with the identification of a target nucleic acid whose function is to be modulated. This target

nucleic acid may be, for example, a cellular gene (or mRNA transcribed from the gene) whose expression is associated with a particular disorder or disease state, or a nucleic acid molecule from an infectious agent. In the present invention, the target nucleic acid encodes kinesin-like 1.

[0037] The targeting process usually also includes determination of at least one target region, segment, or site within the target nucleic acid for the antisense interaction to occur such that the desired effect, e.g., modulation of expression, will result. Within the context of the present invention, the term "region" is defined as a portion of the target nucleic acid having at least one identifiable structure, function, or characteristic. Within regions of target nucleic acids are segments. "Segments" are defined as smaller or sub-portions of regions within a target nucleic acid. "Sites," as used in the present invention, are defined as positions within a target nucleic acid.

[0038] Since, as is known in the art, the translation initiation codon is typically 5'-AUG (in transcribed mRNA molecules; 5'-ATG in the corresponding DNA molecule), the translation initiation codon is also referred to as the "AUG codon," the "start codon" or the "AUG start codon". A minority of genes have a translation initiation codon having the RNA sequence 5'-GUG, 5'-UUG or 5'-CUG, and 5'-AUA, 5'-ACG and 5'-CUG have been shown to function *in vivo*. Thus, the terms "translation initiation codon" and "start codon" can encompass many codon sequences, even though the initiator amino acid in each instance is typically methionine (in eukaryotes) or formylmethionine (in prokaryotes). It is also known in the art that eukaryotic and prokaryotic genes may have two or more alternative start codons, any one of which may be preferentially utilized for translation initiation in a particular cell type or tissue, or under a particular set of conditions. In the context of the invention, "start codon" and "translation initiation codon" refer to the codon or codons that are used *in vivo* to initiate translation of an mRNA transcribed from a gene encoding kinesin-like 1, regardless of the sequence(s) of such codons. It is also known in the art that a translation termination codon (or "stop codon") of a gene may have one of three sequences, i.e., 5'-UAA, 5'-UAG and 5'-UGA (the corresponding DNA sequences are 5'-TAA, 5'-TAG and 5'-TGA, respectively).

[0039] The terms "start codon region" and "translation initiation codon region" refer to a portion of such an mRNA or gene that encompasses from about 25 to about 50 contiguous nucleotides in either direction (i.e., 5' or 3') from a translation initiation codon.

Similarly, the terms "stop codon region" and "translation termination codon region" refer to a portion of such an mRNA or gene that encompasses from about 25 to about 50 contiguous nucleotides in either direction (i.e., 5' or 3') from a translation termination codon.

Consequently, the "start codon region" (or "translation initiation codon region") and the "stop codon region" (or "translation termination codon region") are all regions which may be targeted effectively with the antisense compounds of the present invention.

[0040] The open reading frame (ORF) or "coding region," which is known in the art to refer to the region between the translation initiation codon and the translation termination codon, is also a region which may be targeted effectively. Within the context of the present invention, a preferred region is the intragenic region encompassing the translation initiation or termination codon of the open reading frame (ORF) of a gene.

[0041] Other target regions include the 5' untranslated region (5'UTR), known in the art to refer to the portion of an mRNA in the 5' direction from the translation initiation codon, and thus including nucleotides between the 5' cap site and the translation initiation codon of an mRNA (or corresponding nucleotides on the gene), and the 3' untranslated region (3'UTR), known in the art to refer to the portion of an mRNA in the 3' direction from the translation termination codon, and thus including nucleotides between the translation termination codon and 3' end of an mRNA (or corresponding nucleotides on the gene). The 5' cap site of an mRNA comprises an N7-methylated guanosine residue joined to the 5'-most residue of the mRNA via a 5'-5' triphosphate linkage. The 5' cap region of an mRNA is considered to include the 5' cap structure itself as well as the first 50 nucleotides adjacent to the cap site. It is also preferred to target the 5' cap region.

[0042] Although some eukaryotic mRNA transcripts are directly translated, many contain one or more regions, known as "introns," which are excised from a transcript before it is translated. The remaining (and therefore translated) regions are known as "exons" and are spliced together to form a continuous mRNA sequence. Targeting splice sites, i.e., intron-exon junctions or exon-intron junctions, may also be particularly useful in situations where aberrant splicing is implicated in disease, or where an overproduction of a particular splice product is implicated in disease. Aberrant fusion junctions due to rearrangements or deletions are also preferred target sites. mRNA transcripts produced via the process of splicing of two (or more) mRNAs from different gene sources are known as "fusion

transcripts". It is also known that introns can be effectively targeted using antisense compounds targeted to, for example, DNA or pre-mRNA.

[0043] It is also known in the art that alternative RNA transcripts can be produced from the same genomic region of DNA. These alternative transcripts are generally known as "variants". More specifically, "pre-mRNA variants" are transcripts produced from the same genomic DNA that differ from other transcripts produced from the same genomic DNA in either their start or stop position and contain both intronic and exonic sequence.

[0044] Upon excision of one or more exon or intron regions, or portions thereof during splicing, pre-mRNA variants produce smaller "mRNA variants". Consequently, mRNA variants are processed pre-mRNA variants and each unique pre-mRNA variant must always produce a unique mRNA variant as a result of splicing. These mRNA variants are also known as "alternative splice variants". If no splicing of the pre-mRNA variant occurs then the pre-mRNA variant is identical to the mRNA variant.

[0045] It is also known in the art that variants can be produced through the use of alternative signals to start or stop transcription and that pre-mRNAs and mRNAs can possess more than one start codon or stop codon. Variants that originate from a pre-mRNA or mRNA that use alternative start codons are known as "alternative start variants" of that pre-mRNA or mRNA. Those transcripts that use an alternative stop codon are known as "alternative stop variants" of that pre-mRNA or mRNA. One specific type of alternative stop variant is the "polyA variant" in which the multiple transcripts produced result from the alternative selection of one of the "polyA stop signals" by the transcription machinery, thereby producing transcripts that terminate at unique polyA sites. Within the context of the invention, the types of variants described herein are also preferred target nucleic acids.

[0046] The locations on the target nucleic acid to which the preferred antisense compounds hybridize are hereinbelow referred to as "preferred target segments." As used herein the term "preferred target segment" is defined as at least an 8-nucleobase portion of a target region to which an active antisense compound is targeted. While not wishing to be bound by theory, it is presently believed that these target segments represent portions of the target nucleic acid which are accessible for hybridization.

[0047] While the specific sequences of certain preferred target segments are set forth herein, one of skill in the art will recognize that these serve to illustrate and describe

particular embodiments within the scope of the present invention. Additional preferred target segments may be identified by one having ordinary skill.

[0048] Target segments 8-80 nucleobases in length comprising a stretch of at least eight (8) consecutive nucleobases selected from within the illustrative preferred target segments are considered to be suitable for targeting as well.

[0049] Target segments can include DNA or RNA sequences that comprise at least the 8 consecutive nucleobases from the 5'-terminus of one of the illustrative preferred target segments (the remaining nucleobases being a consecutive stretch of the same DNA or RNA beginning immediately upstream of the 5'-terminus of the target segment and continuing until the DNA or RNA contains about 8 to about 80 nucleobases). Similarly preferred target segments are represented by DNA or RNA sequences that comprise at least the 8 consecutive nucleobases from the 3'-terminus of one of the illustrative preferred target segments (the remaining nucleobases being a consecutive stretch of the same DNA or RNA beginning immediately downstream of the 3'-terminus of the target segment and continuing until the DNA or RNA contains about 8 to about 80 nucleobases). It is also understood that preferred antisense target segments may be represented by DNA or RNA sequences that comprise at least 8 consecutive nucleobases from an internal portion of the sequence of an illustrative preferred target segment, and may extend in either or both directions until the oligonucleotide contains about 8 to about 80 nucleobases. One having skill in the art armed with the preferred target segments illustrated herein will be able, without undue experimentation, to identify further preferred target segments.

[0050] Once one or more target regions, segments or sites have been identified, antisense compounds are chosen which are sufficiently complementary to the target, i.e., hybridize sufficiently well and with sufficient specificity, to give the desired effect.

[0051] The oligomeric antisense compounds may also be targeted to regions of the target nucleobase sequence (e.g., such as those disclosed in Examples below) comprising nucleobases 1-80, 81-160, 161-240, 241-320, 321-400, 401-480, ..., etc, or any combination thereof.

#### **D. Screening and Target Validation**

[0052] In a further embodiment, the "preferred target segments" identified herein may be employed in a screen for additional compounds that modulate the expression of

kinesin-like 1. "Modulators" are those compounds that decrease or increase the expression of a nucleic acid molecule encoding kinesin-like 1 and which comprise at least an 8-nucleobase portion which is complementary to a preferred target segment. The screening method comprises the steps of contacting a preferred target segment of a nucleic acid molecule encoding kinesin-like 1 with one or more candidate modulators, and selecting for one or more candidate modulators which decrease or increase the expression of a nucleic acid molecule encoding kinesin-like 1. Once it is shown that the candidate modulator or modulators are capable of modulating (e.g. either decreasing or increasing) the expression of a nucleic acid molecule encoding kinesin-like 1, the modulator may then be employed in further investigative studies of the function of kinesin-like 1, or for use as a research, diagnostic, or therapeutic agent in accordance with the present invention.

[0053] The preferred target segments of the present invention may be also be combined with their respective complementary antisense compounds of the present invention to form stabilized double-stranded (duplexed) oligonucleotides.

[0054] Such double stranded oligonucleotide moieties have been shown in the art to modulate target expression and regulate translation as well as RNA processing via an antisense mechanism. Moreover, the double-stranded moieties may be subject to chemical modifications (Fire et al., *Nature*, **1998**, *391*, 806-811; Timmons and Fire, *Nature* **1998**, *395*, 854; Timmons et al., *Gene*, **2001**, *263*, 103-112; Tabara et al., *Science*, **1998**, *282*, 430-431; Montgomery et al., *Proc. Natl. Acad. Sci. USA*, **1998**, *95*, 15502-15507; Tuschl et al., *Genes Dev.*, **1999**, *13*, 3191-3197; Elbashir et al., *Nature*, **2001**, *411*, 494-498; Elbashir et al., *Genes Dev.* **2001**, *15*, 188-200). For example, such double-stranded moieties have been shown to inhibit the target by the classical hybridization of antisense strand of the duplex to the target, thereby triggering enzymatic degradation of the target (Tijsterman et al., *Science*, **2002**, *295*, 694-697).

[0055] The antisense compounds of the present invention can also be applied in the areas of drug discovery and target validation. The present invention comprehends the use of the compounds and preferred target segments identified herein in drug discovery efforts to elucidate relationships that exist between kinesin-like 1 and a disease state, phenotype, or condition. These methods include detecting or modulating kinesin-like 1 comprising contacting a sample, tissue, cell, or organism with the compounds of the present invention, measuring the nucleic acid or protein level of kinesin-like 1 and/or a related

phenotypic or chemical endpoint at some time after treatment, and optionally comparing the measured value to a non-treated sample or sample treated with a further compound of the invention. These methods can also be performed in parallel or in combination with other experiments to determine the function of unknown genes for the process of target validation or to determine the validity of a particular gene product as a target for treatment or prevention of a particular disease, condition, or phenotype.

#### **E. Kits, Research Reagents, Diagnostics, and Therapeutics**

[0056] The antisense compounds of the present invention can be utilized for diagnostics, therapeutics, prophylaxis and as research reagents and kits. Furthermore, antisense oligonucleotides, which are able to inhibit gene expression with exquisite specificity, are often used by those of ordinary skill to elucidate the function of particular genes or to distinguish between functions of various members of a biological pathway.

[0057] For use in kits and diagnostics, the compounds of the present invention, either alone or in combination with other compounds or therapeutics, can be used as tools in differential and/or combinatorial analyses to elucidate expression patterns of a portion or the entire complement of genes expressed within cells and tissues.

[0058] As one nonlimiting example, expression patterns within cells or tissues treated with one or more antisense compounds are compared to control cells or tissues not treated with antisense compounds and the patterns produced are analyzed for differential levels of gene expression as they pertain, for example, to disease association, signaling pathway, cellular localization, expression level, size, structure or function of the genes examined. These analyses can be performed on stimulated or unstimulated cells and in the presence or absence of other compounds which affect expression patterns.

[0059] Examples of methods of gene expression analysis known in the art include DNA arrays or microarrays (Brazma and Vilo, *FEBS Lett.*, **2000**, 480, 17-24; Celis, *et al.*, *FEBS Lett.*, **2000**, 480, 2-16), SAGE (serial analysis of gene expression)(Madden, *et al.*, *Drug Discov. Today*, **2000**, 5, 415-425), READS (restriction enzyme amplification of digested cDNAs) (Prashar and Weissman, *Methods Enzymol.*, **1999**, 303, 258-72), TOGA (total gene expression analysis) (Sutcliffe, *et al.*, *Proc. Natl. Acad. Sci. U. S. A.*, **2000**, 97, 1976-81), protein arrays and proteomics (Celis, *et al.*, *FEBS Lett.*, **2000**, 480, 2-16; Jungblut, *et al.*, *Electrophoresis*, **1999**, 20, 2100-10), expressed sequence tag (EST)



sequencing (Celis, *et al.*, *FEBS Lett.*, **2000**, 480, 2-16; Larsson, *et al.*, *J. Biotechnol.*, **2000**, 80, 143-57), subtractive RNA fingerprinting (SuRF) (Fuchs, *et al.*, *Anal. Biochem.*, **2000**, 286, 91-98; Larson, *et al.*, *Cytometry*, **2000**, 41, 203-208), subtractive cloning, differential display (DD) (Jurecic and Belmont, *Curr. Opin. Microbiol.*, **2000**, 3, 316-21), comparative genomic hybridization (Carulli, *et al.*, *J. Cell Biochem. Suppl.*, **1998**, 31, 286-96), FISH (fluorescent *in situ* hybridization) techniques (Going and Gusterson, *Eur. J. Cancer*, **1999**, 35, 1895-904) and mass spectrometry methods (To, *Comb. Chem. High Throughput Screen*, **2000**, 3, 235-41).

[0060] The antisense compounds of the invention are useful for research and diagnostics, because these compounds hybridize to nucleic acids encoding kinesin-like 1. For example, oligonucleotides that are shown to hybridize with such efficiency and under such conditions as disclosed herein as to be effective kinesin-like 1 inhibitors will also be effective primers or probes under conditions favoring gene amplification or detection, respectively. These primers and probes are useful in methods requiring the specific detection of nucleic acid molecules encoding kinesin-like 1 and in the amplification of said nucleic acid molecules for detection or for use in further studies of kinesin-like 1. Hybridization of the antisense oligonucleotides, particularly the primers and probes, of the invention with a nucleic acid encoding kinesin-like 1 can be detected by means known in the art. Such means may include conjugation of an enzyme to the oligonucleotide, radiolabelling of the oligonucleotide or any other suitable detection means. Kits using such detection means for detecting the level of kinesin-like 1 in a sample may also be prepared.

[0061] The specificity and sensitivity of antisense is also harnessed by those of skill in the art for therapeutic uses. Antisense compounds have been employed as therapeutic moieties in the treatment of disease states in animals, including humans. Antisense oligonucleotide drugs, including ribozymes, have been safely and effectively administered to humans and numerous clinical trials are presently underway. It is thus established that antisense compounds can be useful therapeutic modalities that can be configured to be useful in treatment regimes for the treatment of cells, tissues and animals, especially humans.

[0062] For therapeutics, an animal, preferably a human, suspected of having a disease or disorder which can be treated by modulating the expression of kinesin-like 1 is treated by administering antisense compounds in accordance with this invention. For

example, in one non-limiting embodiment, the methods comprise the step of administering to the animal in need of treatment, a therapeutically effective amount of a kinesin-like 1 inhibitor. The kinesin-like 1 inhibitors of the present invention effectively inhibit the activity of the kinesin-like 1 protein or inhibit the expression of the kinesin-like 1 protein. In one embodiment, the activity or expression of kinesin-like 1 in an animal is inhibited by about 10%. Preferably, the activity or expression of kinesin-like 1 in an animal is inhibited by about 30%. More preferably, the activity or expression of kinesin-like 1 in an animal is inhibited by 50% or more. Thus, the oligomeric antisense compounds modulate expression of kinesin-like 1 mRNA by at least 10%, by at least 20%, by at least 25%, by at least 30%, by at least 40%, by at least 50%, by at least 60%, by at least 70%, by at least 75%, by at least 80%, by at least 85%, by at least 90%, by at least 95%, by at least 98%, by at least 99%, or by 100%.

[0063] For example, the reduction of the expression of kinesin-like 1 may be measured in serum, adipose tissue, liver or any other body fluid, tissue or organ of the animal. Preferably, the cells contained within said fluids, tissues or organs being analyzed contain a nucleic acid molecule encoding kinesin-like 1 protein and/or the kinesin-like 1 protein itself.

[0064] The antisense compounds of the invention can be utilized in pharmaceutical compositions by adding an effective amount of a compound to a suitable pharmaceutically acceptable diluent or carrier. Use of the compounds and methods of the invention may also be useful prophylactically.

#### **F. Modifications**

[0065] As is known in the art, a nucleoside is a base-sugar combination. The base portion of the nucleoside is normally a heterocyclic base sometimes referred to as a "nucleobase" or simply a "base". The two most common classes of such heterocyclic bases are the purines and the pyrimidines. Nucleotides are nucleosides that further include a phosphate group covalently linked to the sugar portion of the nucleoside. For those nucleosides that include a pentofuranosyl sugar, the phosphate group can be linked to either the 2', 3' or 5' hydroxyl moiety of the sugar. In forming oligonucleotides, the phosphate groups covalently link adjacent nucleosides to one another to form a linear polymeric compound. In turn, the respective ends of this linear polymeric compound can be further

joined to form a circular compound, however, linear compounds are generally preferred. In addition, linear compounds may have internal nucleobase complementarity and may therefore fold in a manner as to produce a fully or partially double-stranded compound. Within oligonucleotides, the phosphate groups are commonly referred to as forming the internucleoside backbone of the oligonucleotide. The normal linkage or backbone of RNA and DNA is a 3' to 5' phosphodiester linkage.

*Modified Internucleoside Linkages (Backbones)*

[0066] Specific examples of preferred antisense compounds useful in this invention include oligonucleotides containing modified backbones or non-natural internucleoside linkages. As defined in this specification, oligonucleotides having modified backbones include those that retain a phosphorus atom in the backbone and those that do not have a phosphorus atom in the backbone. For the purposes of this specification, and as sometimes referenced in the art, modified oligonucleotides that do not have a phosphorus atom in their internucleoside backbone can also be considered to be oligonucleosides.

[0067] Preferred modified oligonucleotide backbones containing a phosphorus atom therein include, for example, phosphorothioates, chiral phosphorothioates, phosphorodithioates, phosphotriesters, aminoalkylphosphotriaminoalkylphosphotriesters, methyl and other alkyl phosphonates including 3'-alkylene phosphonates, 5'-alkylene phosphonates and chiral phosphonates, phosphinates, phosphoramidates including 3'-amino phosphoramidate and aminoalkylphosphoramidates, thionophosphoramidates, thionoalkylphosphonates, thionoalkylphosphotriesters, selenophosphates and boranophosphates having normal 3'-5' linkages, 2'-5' linked analogs of these, and those having inverted polarity wherein one or more internucleotide linkages is a 3' to 3', 5' to 5' or 2' to 2' linkage. Preferred oligonucleotides having inverted polarity comprise a single 3' to 3' linkage at the 3'-most internucleotide linkage i.e. a single inverted nucleoside residue which may be abasic (the nucleobase is missing or has a hydroxyl group in place thereof). Various salts, mixed salts and free acid forms are also included.

[0068] Representative United States patents that teach the preparation of the above phosphorus-containing linkages include, but are not limited to, U.S.: 3,687,808; 4,469,863; 4,476,301; 5,023,243; 5,177,196; 5,188,897; 5,264,423; 5,276,019; 5,278,302; 5,286,717; 5,321,131; 5,399,676; 5,405,939; 5,453,496; 5,455,233; 5,466,677; 5,476,925; 5,519,126;

5,536,821; 5,541,306; 5,550,111; 5,563,253; 5,571,799; 5,587,361; 5,194,599; 5,565,555; 5,527,899; 5,721,218; 5,672,697 and 5,625,050, certain of which are commonly owned with this application, and each of which is herein incorporated by reference.

[0069] Preferred modified oligonucleotide backbones that do not include a phosphorus atom therein have backbones that are formed by short chain alkyl or cycloalkyl internucleoside linkages, mixed heteroatom and alkyl or cycloalkyl internucleoside linkages, or one or more short chain heteroatomic or heterocyclic internucleoside linkages. These include those having morpholino linkages (formed in part from the sugar portion of a nucleoside); siloxane backbones; sulfide, sulfoxide and sulfone backbones; formacetyl and thioformacetyl backbones; methylene formacetyl and thioformacetyl backbones; riboacetyl backbones; alkene containing backbones; sulfamate backbones; methyleneimino and methylenehydrazino backbones; sulfonate and sulfonamide backbones; amide backbones; and others having mixed N, O, S and CH<sub>2</sub> component parts.

[0070] Representative United States patents that teach the preparation of the above oligonucleosides include, but are not limited to, U.S.: 5,034,506; 5,166,315; 5,185,444; 5,214,134; 5,216,141; 5,235,033; 5,264,562; 5,264,564; 5,405,938; 5,434,257; 5,466,677; 5,470,967; 5,489,677; 5,541,307; 5,561,225; 5,596,086; 5,602,240; 5,610,289; 5,602,240; 5,608,046; 5,610,289; 5,618,704; 5,623,070; 5,663,312; 5,633,360; 5,677,437; 5,792,608; 5,646,269 and 5,677,439, certain of which are commonly owned with this application, and each of which is herein incorporated by reference.

#### *Modified sugar and internucleoside linkages-Mimetics*

[0071] In other preferred antisense compounds, e.g., oligonucleotide mimetics, both the sugar and the internucleoside linkage (i.e. the backbone), of the nucleotide units are replaced with novel groups. The nucleobase units are maintained for hybridization with an appropriate target nucleic acid. One such compound, an oligonucleotide mimetic that has been shown to have excellent hybridization properties, is referred to as a peptide nucleic acid (PNA). In PNA compounds, the sugar-backbone of an oligonucleotide is replaced with an amide containing backbone, in particular an aminoethylglycine backbone. The nucleobases are retained and are bound directly or indirectly to aza nitrogen atoms of the amide portion of the backbone. Representative United States patents that teach the preparation of PNA compounds include, but are not limited to, U.S.: 5,539,082; 5,714,331;

and 5,719,262, each of which is herein incorporated by reference. Further teaching of PNA compounds can be found in Nielsen *et al.*, *Science*, **1991**, 254, 1497-1500.

[0072] Preferred embodiments of the invention are oligonucleotides with phosphorothioate backbones and oligonucleosides with heteroatom backbones, and in particular -CH<sub>2</sub>-NH-O-CH<sub>2</sub>-, -CH<sub>2</sub>-N(CH<sub>3</sub>)-O-CH<sub>2</sub>- [known as a methylene (methylimino) or MMI backbone], -CH<sub>2</sub>-O-N(CH<sub>3</sub>)-CH<sub>2</sub>-, -CH<sub>2</sub>-N(CH<sub>3</sub>)-N(CH<sub>3</sub>)-CH<sub>2</sub>- and -O-N(CH<sub>3</sub>)-CH<sub>2</sub>-CH<sub>2</sub>- [wherein the native phosphodiester backbone is represented as -O-P-O-CH<sub>2</sub>-] of the above referenced U.S. patent 5,489,677, and the amide backbones of the above referenced U.S. patent 5,602,240. Also preferred are oligonucleotides having morpholino backbone structures of the above-referenced U.S. patent 5,034,506.

#### *Modified sugars*

[0073] Modified antisense compounds may also contain one or more substituted sugar moieties. Preferred are antisense compounds, preferably antisense oligonucleotides, comprising one of the following at the 2' position: OH; F; O-, S-, or N-alkyl; O-, S-, or N-alkenyl; O-, S- or N-alkynyl; or O-alkyl-O-alkyl, wherein the alkyl, alkenyl and alkynyl may be substituted or unsubstituted C<sub>1</sub> to C<sub>10</sub> alkyl or C<sub>2</sub> to C<sub>10</sub> alkenyl and alkynyl. Particularly preferred are O[(CH<sub>2</sub>)<sub>n</sub>O]<sub>m</sub>CH<sub>3</sub>, O(CH<sub>2</sub>)<sub>n</sub>OCH<sub>3</sub>, O(CH<sub>2</sub>)<sub>n</sub>NH<sub>2</sub>, O(CH<sub>2</sub>)<sub>n</sub>CH<sub>3</sub>, O(CH<sub>2</sub>)<sub>n</sub>ONH<sub>2</sub>, and O(CH<sub>2</sub>)<sub>n</sub>ON[(CH<sub>2</sub>)<sub>n</sub>CH<sub>3</sub>]<sub>2</sub>, where n and m are from 1 to about 10. Other preferred oligonucleotides comprise one of the following at the 2' position: C<sub>1</sub> to C<sub>10</sub> lower alkyl, substituted lower alkyl, alkenyl, alkynyl, alkaryl, aralkyl, O-alkaryl or O-aralkyl, SH, SCH<sub>3</sub>, OCN, Cl, Br, CN, CF<sub>3</sub>, OCF<sub>3</sub>, SOCH<sub>3</sub>, SO<sub>2</sub>CH<sub>3</sub>, ONO<sub>2</sub>, NO<sub>2</sub>, N<sub>3</sub>, NH<sub>2</sub>, heterocycloalkyl, heterocycloalkaryl, aminoalkylamino, polyalkylamino, substituted silyl, an RNA cleaving group, a reporter group, an intercalator, a group for improving the pharmacokinetic properties of an oligonucleotide, or a group for improving the pharmacodynamic properties of an oligonucleotide, and other substituents having similar properties. A preferred modification includes 2'-methoxyethoxy (2'-O-CH<sub>2</sub>CH<sub>2</sub>OCH<sub>3</sub>, also known as 2'-O-(2-methoxyethyl) or 2'-MOE) (Martin *et al.*, *Helv. Chim. Acta*, **1995**, 78, 486-504) i.e., an alkoxyalkoxy group. A further preferred modification includes 2'-dimethylaminoethoxy, i.e., a O(CH<sub>2</sub>)<sub>2</sub>ON(CH<sub>3</sub>)<sub>2</sub> group, also known as 2'-DMAOE, as described in examples hereinbelow, and 2'-dimethylaminoethoxyethoxy (also known in the art as 2'-O-dimethyl-amino-ethoxy-ethyl or 2'-DMAEOE), i.e., 2'-O-CH<sub>2</sub>-O-CH<sub>2</sub>-N(CH<sub>3</sub>)<sub>2</sub>,

also described in examples hereinbelow.

[0074] Other preferred modifications include 2'-methoxy (2'-O-CH<sub>3</sub>), 2'-aminopropoxy (2'-OCH<sub>2</sub>CH<sub>2</sub>CH<sub>2</sub>NH<sub>2</sub>), 2'-allyl (2'-CH<sub>2</sub>-CH=CH<sub>2</sub>), 2'-O-allyl (2'-O-CH<sub>2</sub>-CH=CH<sub>2</sub>) and 2'-fluoro (2'-F). The 2'-modification may be in the arabino (up) position or ribo (down) position. A preferred 2'-arabino modification is 2'-F. Similar modifications may also be made at other positions on the oligonucleotide, particularly the 3' position of the sugar on the 3' terminal nucleotide or in 2'-5' linked oligonucleotides and the 5' position of 5' terminal nucleotide. Antisense compounds may also have sugar mimetics such as cyclobutyl moieties in place of the pentofuranosyl sugar. Representative United States patents that teach the preparation of such modified sugar structures include, but are not limited to, U.S.: 4,981,957; 5,118,800; 5,319,080; 5,359,044; 5,393,878; 5,446,137; 5,466,786; 5,514,785; 5,519,134; 5,567,811; 5,576,427; 5,591,722; 5,597,909; 5,610,300; 5,627,053; 5,639,873; 5,646,265; 5,658,873; 5,670,633; 5,792,747; and 5,700,920, certain of which are commonly owned with the instant application, and each of which is herein incorporated by reference in its entirety.

[0075] A further preferred modification of the sugar includes Locked Nucleic Acids (LNAs) in which the 2'-hydroxyl group is linked to the 3' or 4' carbon atom of the sugar ring, thereby forming a bicyclic sugar moiety. The linkage is preferably a methylene (-CH<sub>2</sub>-)<sub>n</sub> group bridging the 2' oxygen atom and the 4' carbon atom wherein n is 1 or 2. LNAs and preparation thereof are described in WO 98/39352 and WO 99/14226.

#### *Natural and Modified Nucleobases*

[0076] Antisense compounds may also include nucleobase (often referred to in the art as heterocyclic base or simply as "base") modifications or substitutions. As used herein, "unmodified" or "natural" nucleobases include the purine bases adenine (A) and guanine (G), and the pyrimidine bases thymine (T), cytosine (C) and uracil (U). Modified nucleobases include other synthetic and natural nucleobases such as 5-methylcytosine (5-me-C), 5-hydroxymethyl cytosine, xanthine, hypoxanthine, 2-aminoadenine, 6-methyl and other alkyl derivatives of adenine and guanine, 2-propyl and other alkyl derivatives of adenine and guanine, 2-thiouracil, 2-thiothymine and 2-thiocytosine, 5-halouracil and cytosine, 5-propynyl (-C≡C-CH<sub>3</sub>) uracil and cytosine and other alkynyl derivatives of pyrimidine bases, 6-azo uracil, cytosine and thymine, 5-uracil (pseudouracil), 4-thiouracil,

8-halo, 8-amino, 8-thiol, 8-thioalkyl, 8-hydroxyl and other 8-substituted adenines and guanines, 5-halo particularly 5-bromo, 5-trifluoromethyl and other 5-substituted uracils and cytosines, 7-methylguanine and 7-methyladenine, 2-F-adenine, 2-amino-adenine, 8-azaguanine and 8-azaadenine, 7-deazaguanine and 7-deazaadenine and 3-deazaguanine and 3-deazaadenine. Further modified nucleobases include tricyclic pyrimidines such as phenoxazine cytidine(1H-pyrimido[5,4-b][1,4]benzoxazin-2(3H)-one), phenothiazine cytidine (1H-pyrimido[5,4-b][1,4]benzothiazin-2(3H)-one), G-clamps such as a substituted phenoxazine cytidine (e.g. 9-(2-aminoethoxy)-H-pyrimido[5,4-b][1,4]benzoxazin-2(3H)-one), carbazole cytidine (2H-pyrimido[4,5-b]indol-2-one), pyridoindole cytidine (H-pyrido[3',2':4,5]pyrrolo[2,3-d]pyrimidin-2-one). Modified nucleobases may also include those in which the purine or pyrimidine base is replaced with other heterocycles, for example 7-deaza-adenine, 7-deazaguanosine, 2-aminopyridine and 2-pyridone. Further nucleobases include those disclosed in United States Patent No. 3,687,808, those disclosed in *The Concise Encyclopedia Of Polymer Science And Engineering*, pages 858-859, Kroschwitz, J.I., ed. John Wiley & Sons, 1990, those disclosed by Englisch *et al.*, *Angewandte Chemie*, International Edition, 1991, 30, 613, and those disclosed by Sanghvi, Y.S., Chapter 15, *Antisense Research and Applications*, pages 289-302, Crooke, S.T. and Lebleu, B. , ed., CRC Press, 1993. Certain of these nucleobases are particularly useful for increasing the binding affinity of the compounds of the invention. These include 5-substituted pyrimidines, 6-azapyrimidines and N-2, N-6 and O-6 substituted purines, including 2-aminopropyladenine, 5-propynyluracil and 5-propynylcytosine. 5-methylcytosine substitutions have been shown to increase nucleic acid duplex stability by 0.6-1.2 °C and are presently preferred base substitutions, even more particularly when combined with 2'-O-methoxyethyl sugar modifications.

[0077] Representative United States patents that teach the preparation of certain of the above noted modified nucleobases as well as other modified nucleobases include, but are not limited to, the above noted U.S. 3,687,808, as well as U.S.: 4,845,205; 5,130,302; 5,134,066; 5,175,273; 5,367,066; 5,432,272; 5,457,187; 5,459,255; 5,484,908; 5,502,177; 5,525,711; 5,552,540; 5,587,469; 5,594,121, 5,596,091; 5,614,617; 5,645,985; 5,830,653; 5,763,588; 6,005,096; and 5,681,941, certain of which are commonly owned with the instant application, and each of which is herein incorporated by reference, and United States

patent 5,750,692, which is commonly owned with the instant application and also herein incorporated by reference.

### *Conjugates*

[0078] Another modification of the antisense compounds of the invention involves chemically linking to the antisense compound one or more moieties or conjugates which enhance the activity, cellular distribution or cellular uptake of the oligonucleotide. These moieties or conjugates can include conjugate groups covalently bound to functional groups such as primary or secondary hydroxyl groups. Conjugate groups of the invention include intercalators, reporter molecules, polyamines, polyamides, polyethylene glycols, polyethers, groups that enhance the pharmacodynamic properties of oligomers, and groups that enhance the pharmacokinetic properties of oligomers. Typical conjugate groups include cholesterol, lipids, phospholipids, biotin, phenazine, folate, phenanthridine, anthraquinone, acridine, fluoresceins, rhodamines, coumarins, and dyes. Groups that enhance the pharmacodynamic properties, in the context of this invention, include groups that improve uptake, enhance resistance to degradation, and/or strengthen sequence-specific hybridization with the target nucleic acid. Groups that enhance the pharmacokinetic properties, in the context of this invention, include groups that improve uptake, distribution, metabolism or excretion of the compounds of the present invention. Representative conjugate groups are disclosed in International Patent Application PCT/US92/09196, filed October 23, 1992, and U.S. Patent 6,287,860, the entire disclosure of which are incorporated herein by reference. Conjugate moieties include but are not limited to lipid moieties such as a cholesterol moiety, cholic acid, a thioether, e.g., hexyl-S-tritylthiol, a thiocholesterol, an aliphatic chain, e.g., dodecandiol or undecyl residues, a phospholipid, e.g., di-hexadecyl-rac-glycerol or triethylammonium 1,2-di-O-hexadecyl-rac-glycero-3-H-phosphonate, a polyamine or a polyethylene glycol chain, or adamantane acetic acid, a palmityl moiety, or an octadecylamine or hexylamino-carbonyl-oxycholesterol moiety. Antisense compounds of the invention may also be conjugated to active drug substances, for example, aspirin, warfarin, phenylbutazone, ibuprofen, suprofen, fenbufen, ketoprofen, (S)-(+)-pranoprofen, carprofen, dansylsarcosine, 2,3,5-triiodobenzoic acid, flufenamic acid, folinic acid, a benzothiadiazide, chlorothiazide, a diazepine, indomethicin, a barbiturate, a cephalosporin, a sulfa drug, an antidiabetic, an antibacterial or an antibiotic. Oligonucleotide-drug



conjugates and their preparation are described in United States Patent Application 09/334,130 (filed June 15, 1999) which is incorporated herein by reference in its entirety.

[0079] Representative United States patents that teach the preparation of such oligonucleotide conjugates include, but are not limited to, U.S.: 4,828,979; 4,948,882; 5,218,105; 5,525,465; 5,541,313; 5,545,730; 5,552,538; 5,578,717; 5,580,731; 5,580,731; 5,591,584; 5,109,124; 5,118,802; 5,138,045; 5,414,077; 5,486,603; 5,512,439; 5,578,718; 5,608,046; 4,587,044; 4,605,735; 4,667,025; 4,762,779; 4,789,737; 4,824,941; 4,835,263; 4,876,335; 4,904,582; 4,958,013; 5,082,830; 5,112,963; 5,214,136; 5,082,830; 5,112,963; 5,214,136; 5,245,022; 5,254,469; 5,258,506; 5,262,536; 5,272,250; 5,292,873; 5,317,098; 5,371,241; 5,391,723; 5,416,203; 5,451,463; 5,510,475; 5,512,667; 5,514,785; 5,565,552; 5,567,810; 5,574,142; 5,585,481; 5,587,371; 5,595,726; 5,597,696; 5,599,923; 5,599,928 and 5,688,941, certain of which are commonly owned with the instant application, and each of which is herein incorporated by reference.

#### *Chimeric compounds*

[0080] It is not necessary for all positions in a given compound to be uniformly modified, and in fact more than one of the aforementioned modifications may be incorporated in a single compound or even at a single nucleoside within an oligonucleotide.

[0081] The present invention also includes antisense compounds which are chimeric compounds. "Chimeric" antisense compounds or "chimeras," in the context of this invention, are antisense compounds, particularly oligonucleotides, which contain two or more chemically distinct regions, each made up of at least one monomer unit, i.e., a nucleotide in the case of an oligonucleotide compound. Chimeric antisense oligonucleotides are thus a form of antisense compound. These oligonucleotides typically contain at least one region wherein the oligonucleotide is modified so as to confer upon the oligonucleotide increased resistance to nuclease degradation, increased cellular uptake, increased stability and/or increased binding affinity for the target nucleic acid. An additional region of the oligonucleotide may serve as a substrate for enzymes capable of cleaving RNA:DNA or RNA:RNA hybrids. By way of example, RNase H is a cellular endonuclease which cleaves the RNA strand of an RNA:DNA duplex. Activation of RNase H, therefore, results in cleavage of the RNA target, thereby greatly enhancing the efficiency of oligonucleotide-mediated inhibition of gene expression. The cleavage of RNA:RNA

hybrids can, in like fashion, be accomplished through the actions of endoribonucleases, such as RNaseL which cleaves both cellular and viral RNA. Cleavage of the RNA target can be routinely detected by gel electrophoresis and, if necessary, associated nucleic acid hybridization techniques known in the art.

[0082] Chimeric antisense compounds of the invention may be formed as composite structures of two or more oligonucleotides, modified oligonucleotides, oligonucleosides and/or oligonucleotide mimetics as described above. Such compounds have also been referred to in the art as hybrids or gapmers. Representative United States patents that teach the preparation of such hybrid structures include, but are not limited to, U.S.: 5,013,830; 5,149,797; 5,220,007; 5,256,775; 5,366,878; 5,403,711; 5,491,133; 5,565,350; 5,623,065; 5,652,355; 5,652,356; and 5,700,922, certain of which are commonly owned with the instant application, and each of which is herein incorporated by reference in its entirety.

#### G. Formulations

[0083] The compounds of the invention may also be admixed, encapsulated, conjugated or otherwise associated with other molecules, molecule structures or mixtures of compounds, as for example, liposomes, receptor-targeted molecules, oral, rectal, topical or other formulations, for assisting in uptake, distribution and/or absorption. Representative United States patents that teach the preparation of such uptake, distribution and/or absorption-assisting formulations include, but are not limited to, U.S.: 5,108,921; 5,354,844; 5,416,016; 5,459,127; 5,521,291; 5,543,158; 5,547,932; 5,583,020; 5,591,721; 4,426,330; 4,534,899; 5,013,556; 5,108,921; 5,213,804; 5,227,170; 5,264,221; 5,356,633; 5,395,619; 5,416,016; 5,417,978; 5,462,854; 5,469,854; 5,512,295; 5,527,528; 5,534,259; 5,543,152; 5,556,948; 5,580,575; and 5,595,756, each of which is herein incorporated by reference.

[0084] The antisense compounds of the invention encompass any pharmaceutically acceptable salts, esters, or salts of such esters, or any other compound which, upon administration to an animal, including a human, is capable of providing (directly or indirectly) the biologically active metabolite or residue thereof.

[0085] The term "pharmaceutically acceptable salts" refers to physiologically and pharmaceutically acceptable salts of the compounds of the invention: i.e., salts that retain

the desired biological activity of the parent compound and do not impart undesired toxicological effects thereto. For oligonucleotides, preferred examples of pharmaceutically acceptable salts and their uses are further described in U.S. Patent 6,287,860, which is incorporated herein in its entirety.

[0086] The present invention also includes pharmaceutical compositions and formulations which include the antisense compounds of the invention. The pharmaceutical compositions of the present invention may be administered in a number of ways depending upon whether local or systemic treatment is desired and upon the area to be treated. Administration may be topical (including ophthalmic and to mucous membranes including vaginal and rectal delivery), pulmonary, e.g., by inhalation or insufflation of powders or aerosols, including by nebulizer; intratracheal, intranasal, epidermal and transdermal), oral or parenteral. Parenteral administration includes intravenous, intraarterial, subcutaneous, intraperitoneal or intramuscular injection or infusion; or intracranial, e.g., intrathecal or intraventricular, administration. Oligonucleotides with at least one 2'-O-methoxyethyl modification are believed to be particularly useful for oral administration. Pharmaceutical compositions and formulations for topical administration may include transdermal patches, ointments, lotions, creams, gels, drops, suppositories, sprays, liquids and powders. Conventional pharmaceutical carriers, aqueous, powder or oily bases, thickeners and the like may be necessary or desirable. Coated condoms, gloves and the like may also be useful.

[0087] The pharmaceutical formulations of the present invention, which may conveniently be presented in unit dosage form, may be prepared according to conventional techniques well known in the pharmaceutical industry. Such techniques include the step of bringing into association the active ingredients with the pharmaceutical carrier(s) or excipient(s). In general, the formulations are prepared by uniformly and intimately bringing into association the active ingredients with liquid carriers or finely divided solid carriers or both, and then, if necessary, shaping the product.

[0088] The compositions of the present invention may be formulated into any of many possible dosage forms such as, but not limited to, tablets, capsules, gel capsules, liquid syrups, soft gels, suppositories, and enemas. The compositions of the present invention may also be formulated as suspensions in aqueous, non-aqueous or mixed media. Aqueous suspensions may further contain substances which increase the viscosity of the

suspension including, for example, sodium carboxymethylcellulose, sorbitol and/or dextran. The suspension may also contain stabilizers.

[0089] Pharmaceutical compositions of the present invention include, but are not limited to, solutions, emulsions, foams and liposome-containing formulations. The pharmaceutical compositions and formulations of the present invention may comprise one or more penetration enhancers, carriers, excipients or other active or inactive ingredients.

[0090] Emulsions are typically heterogenous systems of one liquid dispersed in another in the form of droplets usually exceeding 0.1  $\mu\text{m}$  in diameter. Emulsions may contain additional components in addition to the dispersed phases, and the active drug which may be present as a solution in either the aqueous phase, oily phase or itself as a separate phase. Microemulsions are included as an embodiment of the present invention. Emulsions and their uses are well known in the art and are further described in U.S. Patent 6,287,860, which is incorporated herein in its entirety.

[0091] Formulations of the present invention include liposomal formulations. As used in the present invention, the term "liposome" means a vesicle composed of amphiphilic lipids arranged in a spherical bilayer or bilayers. Liposomes are unilamellar or multilamellar vesicles which have a membrane formed from a lipophilic material and an aqueous interior that contains the composition to be delivered. Cationic liposomes are positively charged liposomes which are believed to interact with negatively charged DNA molecules to form a stable complex. Liposomes that are pH-sensitive or negatively-charged are believed to entrap DNA rather than complex with it. Both cationic and noncationic liposomes have been used to deliver DNA to cells.

[0092] Liposomes also include "sterically stabilized" liposomes, a term which, as used herein, refers to liposomes comprising one or more specialized lipids that, when incorporated into liposomes, result in enhanced circulation lifetimes relative to liposomes lacking such specialized lipids. Examples of sterically stabilized liposomes are those in which part of the vesicle-forming lipid portion of the liposome comprises one or more glycolipids or is derivatized with one or more hydrophilic polymers, such as a polyethylene glycol (PEG) moiety. Liposomes and their uses are further described in U.S. Patent 6,287,860, which is incorporated herein in its entirety.

[0093] The pharmaceutical formulations and compositions of the present invention may also include surfactants. The use of surfactants in drug products, formulations and in

emulsions is well known in the art. Surfactants and their uses are further described in U.S. Patent 6,287,860, which is incorporated herein in its entirety.

[0094] In one embodiment, the present invention employs various penetration enhancers to effect the efficient delivery of nucleic acids, particularly oligonucleotides. In addition to aiding the diffusion of non-lipophilic drugs across cell membranes, penetration enhancers also enhance the permeability of lipophilic drugs. Penetration enhancers may be classified as belonging to one of five broad categories, *i.e.*, surfactants, fatty acids, bile salts, chelating agents, and non-chelating non-surfactants. Penetration enhancers and their uses are further described in U.S. Patent 6,287,860, which is incorporated herein in its entirety.

[0095] One of skill in the art will recognize that formulations are routinely designed according to their intended use, *i.e.* route of administration.

[0096] Preferred formulations for topical administration include those in which the oligonucleotides of the invention are in admixture with a topical delivery agent such as lipids, liposomes, fatty acids, fatty acid esters, steroids, chelating agents and surfactants. Preferred lipids and liposomes include neutral (e.g. dioleoylphosphatidyl DOPE ethanolamine, dimyristoylphosphatidyl choline DMPC, distearoylphosphatidyl choline), negative (e.g. dimyristoylphosphatidyl glycerol DMPG) and cationic (e.g. dioleoyltetramethylaminopropyl DOTAP and dioleoylphosphatidyl ethanolamine DOTMA).

[0097] For topical or other administration, oligonucleotides of the invention may be encapsulated within liposomes or may form complexes thereto, in particular to cationic liposomes. Alternatively, oligonucleotides may be complexed to lipids, in particular to cationic lipids. Preferred fatty acids and esters, pharmaceutically acceptable salts thereof, and their uses are further described in U.S. Patent 6,287,860, which is incorporated herein in its entirety. Topical formulations are described in detail in United States patent application 09/315,298 filed on May 20, 1999, which is incorporated herein by reference in its entirety.

[0098] Compositions and formulations for oral administration include powders or granules, microparticulates, nanoparticulates, suspensions or solutions in water or non-aqueous media, capsules, gel capsules, sachets, tablets or minitables. Thickeners, flavoring agents, diluents, emulsifiers, dispersing aids or binders may be desirable. Preferred oral formulations are those in which oligonucleotides of the invention are administered in

conjunction with one or more penetration enhancers surfactants and chelators. Preferred surfactants include fatty acids and/or esters or salts thereof, bile acids and/or salts thereof. Preferred bile acids/salts and fatty acids and their uses are further described in U.S. Patent 6,287,860, which is incorporated herein in its entirety. Also preferred are combinations of penetration enhancers, for example, fatty acids/salts in combination with bile acids/salts. A particularly preferred combination is the sodium salt of lauric acid, capric acid and UDCA. Further penetration enhancers include polyoxyethylene-9-lauryl ether, polyoxyethylene-20-cetyl ether. Oligonucleotides of the invention may be delivered orally, in granular form including sprayed dried particles, or complexed to form micro or nanoparticles. Oligonucleotide complexing agents and their uses are further described in U.S. Patent 6,287,860, which is incorporated herein in its entirety. Oral formulations for oligonucleotides and their preparation are described in detail in United States applications 09/108,673 (filed July 1, 1998), 09/315,298 (filed May 20, 1999) and 10/071,822, filed February 8, 2002, each of which is incorporated herein by reference in their entirety.

**[0099]** Compositions and formulations for parenteral, intrathecal or intraventricular administration may include sterile aqueous solutions which may also contain buffers, diluents and other suitable additives such as, but not limited to, penetration enhancers, carrier compounds and other pharmaceutically acceptable carriers or excipients.

**[0100]** Certain embodiments of the invention provide pharmaceutical compositions containing one or more oligomeric compounds and one or more other chemotherapeutic agents which function by a non-antisense mechanism. Examples of such chemotherapeutic agents include but are not limited to cancer chemotherapeutic drugs such as daunorubicin, daunomycin, dactinomycin, doxorubicin, epirubicin, idarubicin, esorubicin, bleomycin, mafosfamide, ifosfamide, cytosine arabinoside, bis-chloroethylnitrosurea, busulfan, mitomycin C, actinomycin D, mithramycin, prednisone, hydroxyprogesterone, testosterone, tamoxifen, dacarbazine, procarbazine, hexamethylmelamine, pentamethylmelamine, mitoxantrone, amsacrine, chlorambucil, methylcyclohexylnitrosurea, nitrogen mustards, melphalan, cyclophosphamide, 6-mercaptopurine, 6-thioguanine, cytarabine, 5-azacytidine, hydroxyurea, deoxycoformycin, 4-hydroxyperoxycyclophosphoramide, 5-fluorouracil (5-FU), 5-fluorodeoxyuridine (5-FUdR), methotrexate (MTX), colchicine, taxol, vincristine, vinblastine, etoposide (VP-16), trimetrexate, irinotecan, topotecan, gemcitabine, teniposide, cisplatin and diethylstilbestrol

(DES). When used with the compounds of the invention, such chemotherapeutic agents may be used individually (*e.g.*, 5-FU and oligonucleotide), sequentially (*e.g.*, 5-FU and oligonucleotide for a period of time followed by MTX and oligonucleotide), or in combination with one or more other such chemotherapeutic agents (*e.g.*, 5-FU, MTX and oligonucleotide, or 5-FU, radiotherapy and oligonucleotide). Anti-inflammatory drugs, including but not limited to nonsteroidal anti-inflammatory drugs and corticosteroids, and antiviral drugs, including but not limited to ribivirin, vidarabine, acyclovir and ganciclovir, may also be combined in compositions of the invention. Combinations of antisense compounds and other non-antisense drugs are also within the scope of this invention. Two or more combined compounds may be used together or sequentially.

[0101] In another related embodiment, compositions of the invention may contain one or more antisense compounds, particularly oligonucleotides, targeted to a first nucleic acid and one or more additional antisense compounds targeted to a second nucleic acid target. Alternatively, compositions of the invention may contain two or more antisense compounds targeted to different regions of the same nucleic acid target. Numerous examples of antisense compounds are known in the art. Two or more combined compounds may be used together or sequentially.

#### H. Dosing

[0102] The formulation of therapeutic compositions and their subsequent administration (dosing) is believed to be within the skill of those in the art. Dosing is dependent on severity and responsiveness of the disease state to be treated, with the course of treatment lasting from several days to several months, or until a cure is effected or a diminution of the disease state is achieved. Optimal dosing schedules can be calculated from measurements of drug accumulation in the body of the patient. Persons of ordinary skill can easily determine optimum dosages, dosing methodologies and repetition rates. Optimum dosages may vary depending on the relative potency of individual oligonucleotides, and can generally be estimated based on  $EC_{50}$ s found to be effective in *in vitro* and *in vivo* animal models. In general, dosage is from 0.01 ug to 100 g per kg of body weight, and may be given once or more daily, weekly, monthly or yearly, or even once every 2 to 20 years. Persons of ordinary skill in the art can easily estimate repetition rates for dosing based on measured residence times and concentrations of the drug in bodily

fluids or tissues. Following successful treatment, it may be desirable to have the patient undergo maintenance therapy to prevent the recurrence of the disease state, wherein the oligonucleotide is administered in maintenance doses, ranging from 0.01 ug to 100 g per kg of body weight, once or more daily, to once every 20 years.

[0103] While the present invention has been described with specificity in accordance with certain of its preferred embodiments, the following examples serve only to illustrate the invention and are not intended to limit the same. Each of the references, GenBank accession numbers, and the like recited in the present application is incorporated herein by reference in its entirety.



## EXAMPLES

### Example 1

#### Synthesis of Nucleoside Phosphoramidites

[0104] The following compounds, including amidites and their intermediates were prepared as described in US Patent 6,426,220 and published PCT WO 02/36743; 5'-O-Dimethoxytrityl-thymidine intermediate for 5-methyl dC amidite, 5'-O-Dimethoxytrityl-2'-deoxy-5-methylcytidine intermediate for 5-methyl-dC amidite, 5'-O-Dimethoxytrityl-2'-deoxy-N<sup>4</sup>-benzoyl-5-methylcytidine penultimate intermediate for 5-methyl dC amidite, [5'-O-(4,4'-Dimethoxytriphenylmethyl)-2'-deoxy-N<sup>4</sup>-benzoyl-5-methylcytidin-3'-O-yl]-2-cyanoethyl-*N,N*-diisopropylphosphoramidite (5-methyl dC amidite), 2'-Fluorodeoxyadenosine, 2'-Fluorodeoxyguanosine, 2'-Fluorouridine, 2'-Fluorodeoxycytidine, 2'-O-(2-Methoxyethyl) modified amidites, 2'-O-(2-methoxyethyl)-5-methyluridine intermediate, 5'-O-DMT-2'-O-(2-methoxyethyl)-5-methyluridine penultimate intermediate, [5'-O-(4,4'-Dimethoxytriphenylmethyl)-2'-O-(2-methoxyethyl)-5-methyluridin-3'-O-yl]-2-cyanoethyl-*N,N*-diisopropylphosphoramidite (MOE T amidite), 5'-O-Dimethoxytrityl-2'-O-(2-methoxyethyl)-5-methylcytidine intermediate, 5'-O-dimethoxytrityl-2'-O-(2-methoxyethyl)-N<sup>4</sup>-benzoyl-5-methyl-cytidine penultimate intermediate, [5'-O-(4,4'-Dimethoxytriphenylmethyl)-2'-O-(2-methoxyethyl)-N<sup>4</sup>-benzoyl-5-methylcytidin-3'-O-yl]-2-cyanoethyl-*N,N*-diisopropylphosphoramidite (MOE 5-Me-C amidite), [5'-O-(4,4'-Dimethoxytriphenylmethyl)-2'-O-(2-methoxyethyl)-N<sup>6</sup>-benzoyladenoin-3'-O-yl]-2-cyanoethyl-*N,N*-diisopropylphosphoramidite (MOE A amidite), [5'-O-(4,4'-Dimethoxytriphenylmethyl)-2'-O-(2-methoxyethyl)-N<sup>4</sup>-isobutyrylguanosin-3'-O-yl]-2-cyanoethyl-*N,N*-diisopropylphosphoramidite (MOE G amidite), 2'-O-(Aminooxyethyl) nucleoside amidites and 2'-O-(dimethylaminooxyethyl) nucleoside amidites, 2'-(Dimethylaminooxyethoxy) nucleoside amidites, 5'-O-*tert*-Butyldiphenylsilyl-O<sup>2</sup>-2'-anhydro-5-methyluridine, 5'-O-*tert*-Butyldiphenylsilyl-2'-O-(2-hydroxyethyl)-5-methyluridine, 2'-O-[(2-phthalimidooxy)ethyl]-5'-*t*-butyldiphenylsilyl-5-methyluridine, 5'-O-*tert*-butyldiphenylsilyl-2'-O-[(2-formadoximinooxy)ethyl]-5-methyluridine, 5'-O-*tert*-Butyldiphenylsilyl-2'-O-[*N,N* dimethylaminooxyethyl]-5-methyluridine, 2'-O-(dimethylaminooxyethyl)-5-methyluridine, 5'-O-DMT-2'-O-(dimethylaminooxyethyl)-5-

methyluridine, 5'-O-DMT-2'-O-(2-N,N-dimethylaminoxyethyl)-5-methyluridine-3'-[(2-cyanoethyl)-N,N-diisopropylphosphoramidite], 2'-(Aminooxyethoxy) nucleoside amidites, N2-isobutyryl-6-O-diphenylcarbamoyl-2'-O-(2-ethylacetyl)-5'-O-(4,4'-dimethoxytrityl)guanosine-3'-[(2-cyanoethyl)-N,N-diisopropylphosphoramidite], 2'-dimethylaminoethoxyethoxy (2'-DMAEOE) nucleoside amidites, 2'-O-[2(2-N,N-dimethylaminoethoxy)ethyl]-5-methyl uridine, 5'-O-dimethoxytrityl-2'-O-[2(2-N,N-dimethylaminoethoxy)-ethyl]-5-methyl uridine and 5'-O-Dimethoxytrityl-2'-O-[2(2-N,N-dimethylaminoethoxy)-ethyl]-5-methyl uridine-3'-O-(cyanoethyl-N,N-diisopropyl)phosphoramidite.

### Example 2

#### Oligonucleotide and oligonucleoside synthesis

[0105] The antisense compounds used in accordance with this invention may be conveniently and routinely made through the well-known technique of solid phase synthesis. Equipment for such synthesis is sold by several vendors including, for example, Applied Biosystems (Foster City, CA). Any other means for such synthesis known in the art may additionally or alternatively be employed. It is well known to use similar techniques to prepare oligonucleotides such as the phosphorothioates and alkylated derivatives.

[0106] Oligonucleotides: Unsubstituted and substituted phosphodiester (P=O) oligonucleotides are synthesized on an automated DNA synthesizer (Applied Biosystems model 394) using standard phosphoramidite chemistry with oxidation by iodine.

[0107] Phosphorothioates (P=S) are synthesized similar to phosphodiester oligonucleotides with the following exceptions: thiation was effected by utilizing a 10% w/v solution of 3,4-dihydro-2H-benzothiole-3-one 1,1-dioxide in acetonitrile for the oxidation of the phosphite linkages. The thiation reaction step time was increased to 180 sec and preceded by the normal capping step. After cleavage from the CPG column and deblocking in concentrated ammonium hydroxide at 55°C (12-16 hr), the oligonucleotides were recovered by precipitating with >3 volumes of ethanol from a 1 M NH<sub>4</sub>OAc solution. Phosphinate oligonucleotides are prepared as described in U.S. Patent 5,508,270, herein incorporated by reference.

[0108] Alkyl phosphonate oligonucleotides are prepared as described in U.S. Patent 4,469,863, herein incorporated by reference.

[0109] 3'-Deoxy-3'-methylene phosphonate oligonucleotides are prepared as described in U.S. Patents 5,610,289 or 5,625,050, herein incorporated by reference.

[0110] Phosphoramidite oligonucleotides are prepared as described in U.S. Patent, 5,256,775 or U.S. Patent 5,366,878, herein incorporated by reference.

[0111] Alkylphosphonothioate oligonucleotides are prepared as described in published PCT applications PCT/US94/00902 and PCT/US93/06976 (published as WO 94/17093 and WO 94/02499, respectively), herein incorporated by reference.

[0112] 3'-Deoxy-3'-amino phosphoramidate oligonucleotides are prepared as described in U.S. Patent 5,476,925, herein incorporated by reference.

[0113] Phosphotriester oligonucleotides are prepared as described in U.S. Patent 5,023,243, herein incorporated by reference.

[0114] Borano phosphate oligonucleotides are prepared as described in U.S. Patents 5,130,302 and 5,177,198, both herein incorporated by reference.

[0115] Oligonucleosides: Methylenemethylimino linked oligonucleosides, also identified as MMI linked oligonucleosides, methylenedimethylhydrazo linked oligonucleosides, also identified as MDH linked oligonucleosides, and methylenecarbonylamino linked oligonucleosides, also identified as amide-3 linked oligonucleosides, and methyleneaminocarbonyl linked oligonucleosides, also identified as amide-4 linked oligonucleosides, as well as mixed backbone compounds having, for instance, alternating MMI and P=O or P=S linkages are prepared as described in U.S. Patents 5,378,825, 5,386,023, 5,489,677, 5,602,240 and 5,610,289, all of which are herein incorporated by reference.

[0116] Formacetal and thioformacetal linked oligonucleosides are prepared as described in U.S. Patents 5,264,562 and 5,264,564, herein incorporated by reference.

[0117] Ethylene oxide linked oligonucleosides are prepared as described in U.S. Patent 5,223,618, herein incorporated by reference.

**Example 3****RNA Synthesis**

[0118] In general, RNA synthesis chemistry is based on the selective incorporation of various protecting groups at strategic intermediary reactions. Although one of ordinary skill in the art will understand the use of protecting groups in organic synthesis, a useful class of protecting groups includes silyl ethers. In particular bulky silyl ethers are used to protect the 5'-hydroxyl in combination with an acid-labile orthoester protecting group on the 2'-hydroxyl. This set of protecting groups is then used with standard solid-phase synthesis technology. It is important to lastly remove the acid labile orthoester protecting group after all other synthetic steps. Moreover, the early use of the silyl protecting groups during synthesis ensures facile removal when desired, without undesired deprotection of 2' hydroxyl.

[0119] Following this procedure for the sequential protection of the 5'-hydroxyl in combination with protection of the 2'-hydroxyl by protecting groups that are differentially removed and are differentially chemically labile, RNA oligonucleotides were synthesized.

[0120] RNA oligonucleotides are synthesized in a stepwise fashion. Each nucleotide is added sequentially (3' to 5'-direction) to a solid support-bound oligonucleotide. The first nucleoside at the 3'-end of the chain is covalently attached to a solid support. The nucleotide precursor, a ribonucleoside phosphoramidite, and activator are added, coupling the second base onto the 5'-end of the first nucleoside. The support is washed and any unreacted 5'-hydroxyl groups are capped with acetic anhydride to yield 5'-acetyl moieties. The linkage is then oxidized to the more stable and ultimately desired P(V) linkage. At the end of the nucleotide addition cycle, the 5'-silyl group is cleaved with fluoride. The cycle is repeated for each subsequent nucleotide.

[0121] Following synthesis, the methyl protecting groups on the phosphates are cleaved in 30 minutes utilizing 1 M disodium-2-carbamoyl-2-cyanoethylene-1,1-dithiolate trihydrate ( $S_2Na_2$ ) in DMF. The deprotection solution is washed from the solid support-bound oligonucleotide using water. The support is then treated with 40% methylamine in water for 10 minutes at 55 °C. This releases the RNA oligonucleotides into solution, deprotects the exocyclic amines, and modifies the 2'- groups. The oligonucleotides can be analyzed by anion exchange HPLC at this stage.

[0122] The 2'-orthoester groups are the last protecting groups to be removed. The ethylene glycol monoacetate orthoester protecting group developed by Dharmacon Research, Inc. (Lafayette, CO), is one example of a useful orthoester protecting group which, has the following important properties. It is stable to the conditions of nucleoside phosphoramidite synthesis and oligonucleotide synthesis. However, after oligonucleotide synthesis the oligonucleotide is treated with methylamine which not only cleaves the oligonucleotide from the solid support but also removes the acetyl groups from the orthoesters. The resulting 2-ethyl-hydroxyl substituents on the orthoester are less electron withdrawing than the acetylated precursor. As a result, the modified orthoester becomes more labile to acid-catalyzed hydrolysis. Specifically, the rate of cleavage is approximately 10 times faster after the acetyl groups are removed. Therefore, this orthoester possesses sufficient stability in order to be compatible with oligonucleotide synthesis and yet, when subsequently modified, permits deprotection to be carried out under relatively mild aqueous conditions compatible with the final RNA oligonucleotide product.

[0123] Additionally, methods of RNA synthesis are well known in the art (Scaringe, S. A. Ph.D. Thesis, University of Colorado, 1996; Scaringe, S. A., et al., *J. Am. Chem. Soc.*, **1998**, *120*, 11820-11821; Matteucci, M. D. and Caruthers, M. H. *J. Am. Chem. Soc.*, **1981**, *103*, 3185-3191; Beaucage, S. L. and Caruthers, M. H. *Tetrahedron Lett.*, **1981**, *22*, 1859-1862; Dahl, B. J., et al., *Acta Chem. Scand.*, **1990**, *44*, 639-641; Reddy, M. P., et al., *Tetrahedron Lett.*, **1994**, *25*, 4311-4314; Wincott, F. et al., *Nucleic Acids Res.*, **1995**, *23*, 2677-2684; Griffin, B. E., et al., *Tetrahedron*, **1967**, *23*, 2301-2313; Griffin, B. E., et al., *Tetrahedron*, **1967**, *23*, 2315-2331).

[0124] RNA antisense compounds (RNA oligonucleotides) of the present invention can be synthesized by the methods herein or purchased from Dharmacon Research, Inc (Lafayette, CO). Once synthesized, complementary RNA antisense compounds can then be annealed by methods known in the art to form double stranded (duplexed) antisense compounds. For example, duplexes can be formed by combining 30  $\mu$ l of each of the complementary strands of RNA oligonucleotides (50 uM RNA oligonucleotide solution) and 15  $\mu$ l of 5X annealing buffer (100 mM potassium acetate, 30 mM HEPES-KOH pH 7.4, 2 mM magnesium acetate) followed by heating for 1 minute at 90°C, then 1 hour at 37°C. The resulting duplexed antisense compounds can be used in

kits, assays, screens, or other methods to investigate the role of a target nucleic acid, or for diagnostic or therapeutic purposes.

#### Example 4

##### Synthesis of Chimeric Compounds

[0125] Chimeric oligonucleotides, oligonucleosides or mixed oligonucleotides/oligonucleosides of the invention can be of several different types. These include a first type wherein the "gap" segment of linked nucleosides is positioned between 5' and 3' "wing" segments of linked nucleosides and a second "open end" type wherein the "gap" segment is located at either the 3' or the 5' terminus of the oligomeric compound. Oligonucleotides of the first type are also known in the art as "gapmers" or gapped oligonucleotides. Oligonucleotides of the second type are also known in the art as "hemimers" or "wingmers".

##### [2'-O-Me]--[2'-deoxy]--[2'-O-Me] Chimeric Phosphorothioate Oligonucleotides

[0126] Chimeric oligonucleotides having 2'-O-alkyl phosphorothioate and 2'-deoxy phosphorothioate oligonucleotide segments are synthesized using an Applied Biosystems automated DNA synthesizer Model 394, as above. Oligonucleotides are synthesized using the automated synthesizer and 2'-deoxy-5'-dimethoxytrityl-3'-O-phosphoramidite for the DNA portion and 5'-dimethoxytrityl-2'-O-methyl-3'-O-phosphoramidite for 5' and 3' wings. The standard synthesis cycle is modified by incorporating coupling steps with increased reaction times for the 5'-dimethoxytrityl-2'-O-methyl-3'-O-phosphoramidite. The fully protected oligonucleotide is cleaved from the support and deprotected in concentrated ammonia (NH<sub>4</sub>OH) for 12-16 hr at 55°C. The deprotected oligo is then recovered by an appropriate method (precipitation, column chromatography, volume reduced *in vacuo* and analyzed spectrophotometrically for yield and for purity by capillary electrophoresis and by mass spectrometry.

##### [2'-O-(2-Methoxyethyl)]--[2'-deoxy]--[2'-O-(Methoxyethyl)] Chimeric Phosphorothioate Oligonucleotides

[0127] [2'-O-(2-methoxyethyl)]--[2'-deoxy]--[2'-O-(methoxyethyl)] chimeric phosphorothioate oligonucleotides were prepared as per the procedure above for the 2'-O-methyl chimeric oligonucleotide, with the substitution of 2'-O-(methoxyethyl) amidites for

the 2'-O-methyl amidites.

**[2'-O-(2-Methoxyethyl)Phosphodiester]--[2'-deoxy Phosphorothioate]--[2'-O-(2-Methoxyethyl) Phosphodiester] Chimeric Oligonucleotides**

**[0128]** [2'-O-(2-methoxyethyl phosphodiester]--[2'-deoxy phosphorothioate]--[2'-O-(methoxyethyl) phosphodiester] chimeric oligonucleotides are prepared as per the above procedure for the 2'-O-methyl chimeric oligonucleotide with the substitution of 2'-O-(methoxyethyl) amidites for the 2'-O-methyl amidites, oxidation with iodine to generate the phosphodiester internucleotide linkages within the wing portions of the chimeric structures and sulfurization utilizing 3,4-dihydro-2H-benzothio-1,1-dioxide (Beaucage Reagent) to generate the phosphorothioate internucleotide linkages for the center gap.

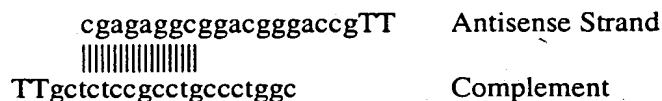
**[0129]** Other chimeric oligonucleotides, chimeric oligonucleosides and mixed chimeric oligonucleotides/oligonucleosides are synthesized according to United States patent 5,623,065, herein incorporated by reference.

**Example 5**

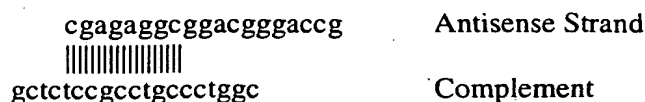
**Design and screening of duplexed antisense compounds targeting kinesin-like 1**

**[0130]** In accordance with the present invention, a series of nucleic acid duplexes comprising the antisense compounds of the present invention and their complements can be designed to target kinesin-like 1. The nucleobase sequence of the antisense strand of the duplex comprises at least an 8-nucleobase portion of an oligonucleotide in Table 1. The ends of the strands may be modified by the addition of one or more natural or modified nucleobases to form an overhang. The sense strand of the dsRNA is then designed and synthesized as the complement of the antisense strand and may also contain modifications or additions to either terminus. For example, in one embodiment, both strands of the dsRNA duplex would be complementary over the central nucleobases, each having overhangs at one or both termini.

**[0131]** For example, a duplex comprising an antisense strand having the sequence CGAGAGGCGGACGGGACCG and having a two-nucleobase overhang of deoxythymidine(dT) would have the following structure:



In another embodiment, a duplex comprising an antisense strand having the same sequence CGAGAGGCGGACGGGACCG may be prepared with blunt ends (no single stranded overhang) as shown:



[0132] RNA strands of the duplex can be synthesized by methods disclosed herein or purchased from Dharmacon Research Inc., (Lafayette, CO). Once synthesized, the complementary strands are annealed. The single strands are aliquoted and diluted to a concentration of 50  $\mu$ M. Once diluted, 30  $\mu$ L of each strand is combined with 15  $\mu$ L of a 5X solution of annealing buffer. The final concentration of said buffer is 100 mM potassium acetate, 30 mM HEPES-KOH pH 7.4, and 2mM magnesium acetate. The final volume is 75  $\mu$ L. This solution is incubated for 1 minute at 90°C and then centrifuged for 15 seconds. The tube is allowed to sit for 1 hour at 37°C at which time the dsRNA duplexes are used in experimentation. The final concentration of the dsRNA duplex is 20  $\mu$ M. This solution can be stored frozen (-20°C) and freeze-thawed up to 5 times.

[0133] Once prepared, the duplexed antisense compounds are evaluated for their ability to modulate kinesin-like 1 expression. When cells reach 80% confluency, they are treated with duplexed antisense compounds of the invention. For cells grown in 96-well plates, wells are washed once with 200  $\mu$ L OPTI-MEM-1 reduced-serum medium (Gibco BRL) and then treated with 130  $\mu$ L of OPTI-MEM-1 containing 12  $\mu$ g/mL LIPOFECTIN (Gibco BRL) and the desired duplex antisense compound at a final concentration of 200 nM. After 5 hours of treatment, the medium is replaced with fresh medium. Cells are harvested 16 hours after treatment, at which time RNA is isolated and target reduction measured by RT-PCR.

### Example 6

#### Oligonucleotide Isolation

[0134] After cleavage from the controlled pore glass solid support and deblocking in concentrated ammonium hydroxide at 55°C for 12-16 hours, the oligonucleotides or oligonucleosides are recovered by precipitation out of 1 M  $\text{NH}_4\text{OAc}$  with >3 volumes of



ethanol. Synthesized oligonucleotides were analyzed by electrospray mass spectroscopy (molecular weight determination) and by capillary gel electrophoresis and judged to be at least 70% full length material. The relative amounts of phosphorothioate and phosphodiester linkages obtained in the synthesis was determined by the ratio of correct molecular weight relative to the -16 amu product (+/-32 +/-48). For some studies oligonucleotides were purified by HPLC, as described by Chiang *et al.*, *J. Biol. Chem.* **1991**, 266, 18162-18171. Results obtained with HPLC-purified material were similar to those obtained with non-HPLC purified material.

#### Example 7

##### Oligonucleotide Synthesis - 96 Well Plate Format

[0135] Oligonucleotides were synthesized via solid phase P(III) phosphoramidite chemistry on an automated synthesizer capable of assembling 96 sequences simultaneously in a 96-well format. Phosphodiester internucleotide linkages were afforded by oxidation with aqueous iodine. Phosphorothioate internucleotide linkages were generated by sulfurization utilizing 3,4-dihydro-2H-benzothiole-3-one 1,1-dioxide (Beaucage Reagent) in anhydrous acetonitrile. Standard base-protected beta-cyanoethyl-diisopropyl phosphoramidites were purchased from commercial vendors (e.g. PE-Applied Biosystems, Foster City, CA, or Pharmacia, Piscataway, NJ). Non-standard nucleosides are synthesized as per standard or patented methods. They are utilized as base protected beta-cyanoethyldiisopropyl phosphoramidites.

[0136] Oligonucleotides were cleaved from support and deprotected with concentrated  $\text{NH}_4\text{OH}$  at elevated temperature (55-60°C) for 12-16 hours and the released product then dried *in vacuo*. The dried product was then re-suspended in sterile water to afford a master plate from which all analytical and test plate samples are then diluted utilizing robotic pipettors.

#### Example 8

##### Oligonucleotide Analysis - 96-Well Plate Format

[0137] The concentration of oligonucleotide in each well was assessed by dilution of samples and UV absorption spectroscopy. The full-length integrity of the individual products was evaluated by capillary electrophoresis (CE) in either the 96-well format

(Beckman P/ACE™ MDQ) or, for individually prepared samples, on a commercial CE apparatus (e.g., Beckman P/ACE™ 5000, ABI 270). Base and backbone composition was confirmed by mass analysis of the compounds utilizing electrospray-mass spectroscopy. All assay test plates were diluted from the master plate using single and multi-channel robotic pipettors. Plates were judged to be acceptable if at least 85% of the compounds on the plate were at least 85% full length.

### **Example 9**

#### **Cell culture and oligonucleotide treatment**

[0138] The effect of antisense compounds on target nucleic acid expression can be tested in any of a variety of cell types provided that the target nucleic acid is present at measurable levels. This can be routinely determined using, for example, PCR or Northern blot analysis. The following cell types are provided for illustrative purposes, but other cell types can be routinely used, provided that the target is expressed in the cell type chosen. This can be readily determined by methods routine in the art, for example Northern blot analysis, ribonuclease protection assays, or RT-PCR.

#### **T-24 cells:**

[0139] The human transitional cell bladder carcinoma cell line T-24 was obtained from the American Type Culture Collection (ATCC) (Manassas, VA). T-24 cells were routinely cultured in complete McCoy's 5A basal media (Invitrogen Corporation, Carlsbad, CA) supplemented with 10% fetal calf serum (Invitrogen Corporation, Carlsbad, CA), penicillin 100 units per mL, and streptomycin 100 micrograms per mL (Invitrogen Corporation, Carlsbad, CA). Cells were routinely passaged by trypsinization and dilution when they reached 90% confluence. Cells were seeded into 96-well plates (Falcon-Primaria #3872) at a density of 7000 cells/well for use in RT-PCR analysis.

[0140] For Northern blotting or other analysis, cells may be seeded onto 100 mm or other standard tissue culture plates and treated similarly, using appropriate volumes of medium and oligonucleotide.

## A549 cells:

[0141] The human lung carcinoma cell line A549 was obtained from the American Type Culture Collection (ATCC) (Manassas, VA). A549 cells were routinely cultured in DMEM basal media (Invitrogen Corporation, Carlsbad, CA) supplemented with 10% fetal calf serum (Invitrogen Corporation, Carlsbad, CA), penicillin 100 units per mL, and streptomycin 100 micrograms per mL (Invitrogen Corporation, Carlsbad, CA). Cells were routinely passaged by trypsinization and dilution when they reached 90% confluence.

## NHDF cells:

[0142] Human neonatal dermal fibroblast (NHDF) were obtained from the Clonetics Corporation (Walkersville, MD). NHDFs were routinely maintained in Fibroblast Growth Medium (Clonetics Corporation, Walkersville, MD) supplemented as recommended by the supplier. Cells were maintained for up to 10 passages as recommended by the supplier.

## HEK cells:

[0143] Human embryonic keratinocytes (HEK) were obtained from the Clonetics Corporation (Walkersville, MD). HEKs were routinely maintained in Keratinocyte Growth Medium (Clonetics Corporation, Walkersville, MD) formulated as recommended by the supplier. Cells were routinely maintained for up to 10 passages as recommended by the supplier.

## T47D cells:

[0144] The T47D breast adenocarcinoma cells were obtained from the American Type Culture Collection (ATCC) (Manassas, VA). Cells were cultured in Gibco DMEM High glucose media supplemented with 10% FBS.

[0145] For cell cycle assays, cells are plated in 24-well plates at 170,000 cells per well.

## MCF7:

[0146] The human breast carcinoma cell line MCF-7 was obtained from the American Type Culture Collection (Manassas, VA). MCF-7 cells were routinely cultured

in DMEM low glucose (Gibco/Life Technologies, Gaithersburg, MD) supplemented with 10% fetal calf serum (Gibco/Life Technologies, Gaithersburg, MD). Cells were routinely passaged by trypsinization and dilution when they reached 90% confluence. Cells were seeded into 96-well plates (Falcon-Primaria #3872) at a density of 7000 cells/well for use in RT-PCR analysis.

[0147] For cell cycle assays, cells are plated in 24-well plates at 140,000 cells per well.

**HMEC:**

[0148] The human mammary epithelial cell line HMEC was obtained from BioWhittaker (Clonetics). HMEC cells were routinely cultured in Mammary Epithelial Growth Medium, BioWhittaker (Clonetics). Cells were routinely passaged by trypsinization and dilution when they reached 70% confluence. Cells were seeded into 24-well plates (Nunc-Nuncolon cat. #143982) at a density of 60,000 cells/well for use in subsequent analyses.

**b.END cells:**

[0149] The mouse brain endothelial cell line b.END was obtained from Dr. Werner Risau at the Max Plank Institute (Bad Nauheim, Germany). b.END cells were routinely cultured in DMEM supplemented with 10% fetal bovine serum (Gibco/Life Technologies, Gaithersburg, MD). Cells were routinely passaged by trypsinization and dilution when they reached 90% confluence. Cells were seeded into 24-well plates (Falcon-Primaria #3047) at a density of 40,000 cells/well for use in RT-PCR analysis.

[0150] For Northern blotting or other analyses, cells may be seeded onto 100 mm or other standard tissue culture plates and treated similarly, using appropriate volumes of medium and oligonucleotide.

**Treatment with antisense compounds:**

[0151] When cells reached 70% confluency, they were treated with oligonucleotide. For cells grown in 96-well plates, wells were washed once with 100  $\mu$ L OPTI-MEM™-1 reduced-serum medium (Invitrogen Corporation, Carlsbad, CA) and then

treated with 130  $\mu$ L of OPTI-MEM™-1 containing 3.75  $\mu$ g/mL LIPOFECTIN™ (Invitrogen Corporation, Carlsbad, CA) and the desired concentration of oligonucleotide. After 4-7 hours of treatment, the medium was replaced with fresh medium. Cells were harvested 16-24 hours after oligonucleotide treatment.

[0152] The concentration of oligonucleotide used varies from cell line to cell line. To determine the optimal oligonucleotide concentration for a particular cell line, the cells are treated with a positive control oligonucleotide at a range of concentrations. For human cells the positive control oligonucleotide is ISIS 13920, **TCCGTCATCGCTCCTCAGGG**, SEQ ID NO: 1, a 2'-O-methoxyethyl gapmer (2'-O-methoxyethyls shown in bold) with a phosphorothioate backbone which is targeted to human H-ras. For mouse or rat cells the positive control oligonucleotide is ISIS 15770, **ATGCATTCTGCCCCCAAGGA**, SEQ ID NO: 2, a 2'-O-methoxyethyl gapmer (2'-O-methoxyethyls shown in bold) with a phosphorothioate backbone which is targeted to both mouse and rat c-raf. The concentration of positive control oligonucleotide that results in 80% inhibition of c-Ha-ras (for ISIS 13920) or c-raf (for ISIS 15770) mRNA is then utilized as the screening concentration for new oligonucleotides in subsequent experiments for that cell line. If 80% inhibition is not achieved, the lowest concentration of positive control oligonucleotide that results in 60% inhibition of H-ras or c-raf mRNA is then utilized as the oligonucleotide screening concentration in subsequent experiments for that cell line. If 60% inhibition is not achieved, that particular cell line is deemed as unsuitable for oligonucleotide transfection experiments.

#### Example 10

##### Analysis of oligonucleotide inhibition of kinesin-like 1 expression

[0153] Antisense modulation of kinesin-like 1 expression can be assayed in a variety of ways known in the art. For example, kinesin-like 1 mRNA levels can be quantitated by, e.g., Northern blot analysis, competitive polymerase chain reaction (PCR), or real-time PCR (RT-PCR). Real-time quantitative PCR is presently preferred. RNA analysis can be performed on total cellular RNA or poly(A)+ mRNA. The preferred method of RNA analysis of the present invention is the use of total cellular RNA as described in other examples herein. Methods of RNA isolation are taught in, for example, Ausubel, F.M. *et al.*, *Current Protocols in Molecular Biology*, Volume 1, pp. 4.1.1-4.2.9 and 4.5.1-4.5.3,

John Wiley & Sons, Inc., 1993. Northern blot analysis is routine in the art and is taught in, for example, Ausubel, F.M. *et al.*, *Current Protocols in Molecular Biology*, Volume 1, pp. 4.2.1-4.2.9, John Wiley & Sons, Inc., 1996. Real-time quantitative (PCR) can be conveniently accomplished using the commercially available ABI PRISM™ 7700 Sequence Detection System, available from PE-Applied Biosystems, Foster City, CA and used according to manufacturer's instructions.

[0154] Protein levels of kinesin-like 1 can be quantitated in a variety of ways well known in the art, such as immunoprecipitation, Western blot analysis (immunoblotting), ELISA or fluorescence-activated cell sorting (FACS). Antibodies directed to kinesin-like 1 can be identified and obtained from a variety of sources, such as the MSRS catalog of antibodies (Aerie Corporation, Birmingham, MI), or can be prepared via conventional antibody generation methods. Methods for preparation of polyclonal antisera are taught in, for example, Ausubel, F.M. *et al.*, (*Current Protocols in Molecular Biology*, Volume 2, pp. 11.12.1-11.12.9, John Wiley & Sons, Inc., 1997). Preparation of monoclonal antibodies is taught in, for example, Ausubel, F.M. *et al.*, (*Current Protocols in Molecular Biology*, Volume 2, pp. 11.4.1-11.11.5, John Wiley & Sons, Inc., 1997).

[0155] Immunoprecipitation methods are standard in the art and can be found at, for example, Ausubel, F.M. *et al.*, (*Current Protocols in Molecular Biology*, Volume 2, pp. 10.16.1-10.16.11, John Wiley & Sons, Inc., 1998). Western blot (immunoblot) analysis is standard in the art and can be found at, for example, Ausubel, F.M. *et al.*, (*Current Protocols in Molecular Biology*, Volume 2, pp. 10.8.1-10.8.21, John Wiley & Sons, Inc., 1997). Enzyme-linked immunosorbent assays (ELISA) are standard in the art and can be found at, for example, Ausubel, F.M. *et al.*, (*Current Protocols in Molecular Biology*, Volume 2, pp. 11.2.1-11.2.22, John Wiley & Sons, Inc., 1991).

### Example 11

#### Poly(A)+ mRNA isolation

[0156] Poly(A)+ mRNA was isolated according to Miura *et al.*, (*Clin. Chem.*, 1996, 42, 1758-1764). Other methods for poly(A)+ mRNA isolation are taught in, for example, Ausubel, F.M. *et al.*, (*Current Protocols in Molecular Biology*, Volume 1, pp. 4.5.1-4.5.3, John Wiley & Sons, Inc., 1993). Briefly, for cells grown on 96-well plates, growth medium was removed from the cells and each well was washed with 200  $\mu$ L cold

PBS. 60  $\mu$ L lysis buffer (10 mM Tris-HCl, pH 7.6, 1 mM EDTA, 0.5 M NaCl, 0.5% NP-40, 20 mM vanadyl-ribonucleoside complex) was added to each well, the plate was gently agitated and then incubated at room temperature for five minutes. 55  $\mu$ L of lysate was transferred to Oligo d(T) coated 96-well plates (AGCT Inc., Irvine CA). Plates were incubated for 60 minutes at room temperature, washed 3 times with 200  $\mu$ L of wash buffer (10 mM Tris-HCl pH 7.6, 1 mM EDTA, 0.3 M NaCl). After the final wash, the plate was blotted on paper towels to remove excess wash buffer and then air-dried for 5 minutes. 60  $\mu$ L of elution buffer (5 mM Tris-HCl pH 7.6), preheated to 70°C, was added to each well, the plate was incubated on a 90°C hot plate for 5 minutes, and the eluate was then transferred to a fresh 96-well plate.

[0157] Cells grown on 100 mm or other standard plates may be treated similarly, using appropriate volumes of all solutions.

### Example 12

#### Total RNA Isolation

[0158] Total RNA was isolated using an RNEASY 96™ kit and buffers purchased from Qiagen Inc. (Valencia, CA) following the manufacturer's recommended procedures. Briefly, for cells grown on 96-well plates, growth medium was removed from the cells and each well was washed with 200  $\mu$ L cold PBS. 150  $\mu$ L Buffer RLT was added to each well and the plate vigorously agitated for 20 seconds. 150  $\mu$ L of 70% ethanol was then added to each well and the contents mixed by pipetting three times up and down. The samples were then transferred to the RNEASY 96™ well plate attached to a QIAVAC™ manifold fitted with a waste collection tray and attached to a vacuum source. Vacuum was applied for 1 minute. 500  $\mu$ L of Buffer RW1 was added to each well of the RNEASY 96™ plate and incubated for 15 minutes and the vacuum was again applied for 1 minute. An additional 500  $\mu$ L of Buffer RW1 was added to each well of the RNEASY 96™ plate and the vacuum was applied for 2 minutes. 1 mL of Buffer RPE was then added to each well of the RNEASY 96™ plate and the vacuum applied for a period of 90 seconds. The Buffer RPE wash was then repeated and the vacuum was applied for an additional 3 minutes. The plate was then removed from the QIAVAC™ manifold and blotted dry on paper towels. The plate was then re-attached to the QIAVAC™ manifold fitted with a collection tube rack

containing 1.2 mL collection tubes. RNA was then eluted by pipetting 170  $\mu$ L water into each well, incubating 1 minute, and then applying the vacuum for 3 minutes.

[0159] The repetitive pipetting and elution steps may be automated using a QIAGEN Bio-Robot 9604 (Qiagen, Inc., Valencia CA). Essentially, after lysing of the cells on the culture plate, the plate is transferred to the robot deck where the pipetting, DNase treatment and elution steps are carried out.

### Example 13

#### Real-time Quantitative PCR Analysis of kinesin-like 1 mRNA Levels

[0160] Quantitation of kinesin-like 1 mRNA levels was determined by real-time quantitative PCR using the ABI PRISM™ 7700 Sequence Detection System (PE-Applied Biosystems, Foster City, CA) according to manufacturer's instructions. This is a closed-tube, non-gel-based, fluorescence detection system which allows high-throughput quantitation of polymerase chain reaction (PCR) products in real-time. As opposed to standard PCR in which amplification products are quantitated after the PCR is completed, products in real-time quantitative PCR are quantitated as they accumulate. This is accomplished by including in the PCR reaction an oligonucleotide probe that anneals specifically between the forward and reverse PCR primers, and contains two fluorescent dyes. A reporter dye (e.g., FAM or JOE, obtained from either PE-Applied Biosystems, Foster City, CA, Operon Technologies Inc., Alameda, CA or Integrated DNA Technologies Inc., Coralville, IA) is attached to the 5' end of the probe and a quencher dye (e.g., TAMRA, obtained from either PE-Applied Biosystems, Foster City, CA, Operon Technologies Inc., Alameda, CA or Integrated DNA Technologies Inc., Coralville, IA) is attached to the 3' end of the probe. When the probe and dyes are intact, reporter dye emission is quenched by the proximity of the 3' quencher dye. During amplification, annealing of the probe to the target sequence creates a substrate that can be cleaved by the 5'-exonuclease activity of Taq polymerase. During the extension phase of the PCR amplification cycle, cleavage of the probe by Taq polymerase releases the reporter dye from the remainder of the probe (and hence from the quencher moiety) and a sequence-specific fluorescent signal is generated. With each cycle, additional reporter dye molecules are cleaved from their respective probes, and the fluorescence intensity is monitored at regular



intervals by laser optics built into the ABI PRISM™ 7700 Sequence Detection System. In each assay, a series of parallel reactions containing serial dilutions of mRNA from untreated control samples generates a standard curve that is used to quantitate the percent inhibition after antisense oligonucleotide treatment of test samples.

[0161] Prior to quantitative PCR analysis, primer-probe sets specific to the target gene being measured are evaluated for their ability to be “multiplexed” with a GAPDH amplification reaction. In multiplexing, both the target gene and the internal standard gene GAPDH are amplified concurrently in a single sample. In this analysis, mRNA isolated from untreated cells is serially diluted. Each dilution is amplified in the presence of primer-probe sets specific for GAPDH only, target gene only (“single-plexing”), or both (multiplexing). Following PCR amplification, standard curves of GAPDH and target mRNA signal as a function of dilution are generated from both the single-plexed and multiplexed samples. If both the slope and correlation coefficient of the GAPDH and target signals generated from the multiplexed samples fall within 10% of their corresponding values generated from the single-plexed samples, the primer-probe set specific for that target is deemed multiplexable. Other methods of PCR are also known in the art.

[0162] PCR reagents were obtained from Invitrogen Corporation, (Carlsbad, CA). RT-PCR reactions were carried out by adding 20 µL PCR cocktail (2.5x PCR buffer (-MgCl<sub>2</sub>), 6.6 mM MgCl<sub>2</sub>, 375 µM each of dATP, dCTP, dCTP and dGTP, 375 nM each of forward primer and reverse primer, 125 nM of probe, 4 Units RNase inhibitor, 1.25 Units PLATINUM® Taq, 5 Units MuLV reverse transcriptase, and 2.5x ROX dye) to 96-well plates containing 30 µL total RNA solution. The RT reaction was carried out by incubation for 30 minutes at 48°C. Following a 10 minute incubation at 95°C to activate the PLATINUM® Taq, 40 cycles of a two-step PCR protocol were carried out: 95°C for 15 seconds (denaturation) followed by 60°C for 1.5 minutes (annealing/extension).

[0163] Gene target quantities obtained by real time RT-PCR are normalized using either the expression level of GAPDH, a gene whose expression is constant, or by quantifying total RNA using RiboGreen™ (Molecular Probes, Inc. Eugene, OR). GAPDH expression is quantified by real time RT-PCR, by being run simultaneously with the target, multiplexing, or separately. Total RNA is quantified using RiboGreen™ RNA quantification reagent from Molecular Probes. Methods of RNA quantification by

RiboGreen™ are taught in Jones, L.J., et al, (Analytical Biochemistry, 1998, 265, 368-374).

[0164] In this assay, 170 µL of RiboGreen™ working reagent (RiboGreen™ reagent diluted 1:350 in 10mM Tris-HCl, 1 mM EDTA, pH 7.5) is pipetted into a 96-well plate containing 30 µL purified, cellular RNA. The plate is read in a CytoFluor 4000 (PE Applied Biosystems) with excitation at 480nm and emission at 520nm.

[0165] Probes and primers to human kinesin-like 1 were designed to hybridize to a human kinesin-like 1 sequence, using published sequence information (GenBank accession number NM\_004523.1, incorporated herein as SEQ ID NO:3). For human kinesin-like 1 the PCR primers were:

forward primer: GTGGTGAGATGCAGACCATTTAAT (SEQ ID NO: 4)

reverse primer: CTTTTCGTACAGGATCACATTCTACTATTG (SEQ ID NO: 5) and the

PCR probe was: FAM-TGGCAGAGCGGAAAGCTAGCGC-TAMRA

() where FAM is the fluorescent dye and TAMRA is the quencher dye. For human GAPDH the PCR primers were:

forward primer: GAAGGTGAAGGTCGGAGTC (SEQ ID NO:7)

reverse primer: GAAGATGGTGATGGGATTTC (SEQ ID NO:8) and the PCR probe was:

5' JOE-CAAGCTTCCCGTTCTCAGCC- TAMRA 3' (SEQ ID NO: 9) where JOE is the fluorescent reporter dye and TAMRA is the quencher dye.

#### Example 14

##### Northern blot analysis of kinesin-like 1 mRNA levels

[0166] Eighteen hours after antisense treatment, cell monolayers were washed twice with cold PBS and lysed in 1 mL RNAZOL™ (TEL-TEST "B" Inc., Friendswood, TX). Total RNA was prepared following manufacturer's recommended protocols. Twenty micrograms of total RNA was fractionated by electrophoresis through 1.2% agarose gels containing 1.1% formaldehyde using a MOPS buffer system (AMRESCO, Inc. Solon, OH). RNA was transferred from the gel to HYBOND™-N+ nylon membranes (Amersham Pharmacia Biotech, Piscataway, NJ) by overnight capillary transfer using a Northern/Southern Transfer buffer system (TEL-TEST "B" Inc., Friendswood, TX). RNA transfer was confirmed by UV visualization. Membranes were fixed by UV cross-linking

using a STRATALINKER™ UV Crosslinker 2400 (Stratagene, Inc, La Jolla, CA) and then probed using QUICKHYB™ hybridization solution (Stratagene, La Jolla, CA) using manufacturer's recommendations for stringent conditions.

[0167] To detect human kinesin-like 1, a human kinesin-like 1 specific probe was prepared by PCR using the forward primer GTGGTGAGATGCAGACCATTTAAT (SEQ ID NO: 4) and the reverse primer CTTTTCGTACAGGATCACATTCTACTATTG (SEQ ID NO: 5). To normalize for variations in loading and transfer efficiency membranes were stripped and probed for human glyceraldehyde-3-phosphate dehydrogenase (GAPDH) RNA (Clontech, Palo Alto, CA).

[0168] Hybridized membranes were visualized and quantitated using a PHOSPHORIMAGER™ and IMAGEQUANT™ Software V3.3 (Molecular Dynamics, Sunnyvale, CA). Data was normalized to GAPDH levels in untreated controls.

#### **Example 15**

##### **Antisense inhibition of human kinesin-like 1 expression by chimeric phosphorothioate oligonucleotides having 2'-MOE wings and a deoxy gap**

[0169] In accordance with the present invention, a series of oligonucleotides were designed to target different regions of the human kinesin-like 1 RNA, using published sequences (GenBank accession number NM\_004523.1, incorporated herein as SEQ ID NO: 3 and 4). The oligonucleotides are shown in Table 1. "Target site" indicates the first (5'-most) nucleotide number on the particular target sequence to which the oligonucleotide binds. All compounds in Table 1 are chimeric oligonucleotides ("gapmers") 20 nucleotides in length, composed of a central "gap" region consisting of ten 2'-deoxynucleotides, which is flanked on both sides (5' and 3' directions) by five-nucleotide "wings". The wings are composed of 2'-methoxyethyl (2'-MOE) nucleotides. The internucleoside (backbone) linkages are phosphorothioate (P=S) throughout the oligonucleotide. All cytidine residues are 5-methylcytidines. The compounds were analyzed for their effect on human kinesin-like 1 mRNA levels by quantitative real-time PCR as described in other examples herein. Data are averages from two experiments in which T-24 cells were treated with the antisense oligonucleotides of the present invention. If present, "N.D." indicates "no data".

Table 1

Inhibition of human kinesin-like 1 mRNA levels by chimeric phosphorothioate oligonucleotides having 2'-MOE wings and a deoxy gap

ISIS #	REGION	TARGET SEQ ID NO	TARGET SITE	SEQUENCE	% INHIB	SEQ ID NO
183876	Coding	3	2284	tgttgactatataccttagat	44	11
183877	Coding	3	1838	tctgctgctaatactgattg	79	12
183878	Coding	3	1771	ctggaatagatgtgagagat	78	13
183879	Coding	3	875	aaagtcaacagggtgattg	69	14
183880	Coding	3	2641	gatcaagaaaaatgttatgc	62	15
183881	Coding	3	1753	atccaagtgtactgttagta	86	16
183882	Coding	3	1027	tttctcaagattgagagat	78	17
183883	Coding	3	2202	caaagcacagaatctctctg	68	18
183884	Coding	3	2172	cattaacttgcaagttcct	58	19
183885	Coding	3	1545	atccagtttggaatggagac	43	20
183886	Coding	3	2881	ttagcatcattaacagctca	72	21
183887	Coding	3	1312	taaacaactctgtaacccta	41	22
183888	Coding	3	528	agaaacatcagatgatggat	82	23
183889	Coding	3	1898	agtgaacttagaagatcagt	66	24
183890	Coding	3	2849	ttcagctgatcaaggagatg	64	25
183891	Coding	3	840	ccgagctctcttatcaacag	81	26
183892	Coding	3	1581	agcttctgcattgtgttggt	76	27
183893	3'UTR	3	3597	attcaactgaatttacagta	56	28
183894	Coding	3	3144	cagaggtaactgtctctttg	66	29
183895	Coding	3	1341	acactggcgaagttcatttt	74	30
183896	Coding	3	1456	cagtactttccaaagctgat	40	31
183897	Coding	3	2119	cagttagggttccacattgc	77	32
183898	3'UTR	3	3707	ctactttatatgaaaactag	30	33
183899	Coding	3	1053	atgagcatattccaatgtac	76	34
183900	Coding	3	536	agtccttcagaaacatcaga	67	35
183901	Coding	3	394	taccagccaagggtatcctct	79	36
183902	Coding	3	489	ttcattatagatctccaaca	39	37
183903	Coding	3	1619	ttaaacagactattcagggt	64	38
183904	Coding	3	2960	tcttcagtatactgccccag	72	39
183905	Coding	3	2301	actgtgaaaagtcattttgt	48	40
183906	Coding	3	1159	caagatctcgttttaaacgt	76	41
183907	Coding	3	308	tggccatacgcaagatagat	34	42
183908	Coding	3	2260	gctgtatatttctctggaca	76	43
183909	Coding	3	1659	ttgctttgagctgccatcct	0	44
183910	Coding	3	2333	gagaagccatcagaatcagc	71	45
183911	Coding	3	1023	ctcaagattgagagatgcag	79	46
183912	Coding	3	2620	gtttctcatgagctgcctta	71	47

[0170] As shown in Table 1, SEQ ID NOs 12, 13, 14, 15, 16, 17, 18, 21, 23, 24, 25, 26, 27, 29, 30, 32, 34, 35, 36, 38, 39, 41, 43, 45, 46 and 47 demonstrated at least 61% inhibition of human kinesin-like 1 expression in this assay and are therefore preferred. The target sites to which these preferred sequences are complementary are herein referred to as "preferred target regions" and are therefore preferred sites for targeting by compounds of the present invention.

**Table 2**  
**Sequence and position of preferred target regions identified in kinesin-like 1**

SITE ID	TARGET SEQ ID NO	TARGET SITE	SEQUENCE	REV COMP OF SEQ ID	ACTIVE IN	SEQ ID NO
99215	3	1838	gaacaatcattagcagcaga	12	<i>H. sapiens</i>	48
99216	3	1771	atctctcacatctattccag	13	<i>H. sapiens</i>	49
99217	3	875	aatcaatccctgttgacttt	14	<i>H. sapiens</i>	50
99218	3	2641	gcataacatttttcttgatc	15	<i>H. sapiens</i>	51
99219	3	1753	tactacagtagcacttgat	16	<i>H. sapiens</i>	52
99220	3	1027	atctctcaatcttgaggaaa	17	<i>H. sapiens</i>	53
99221	3	2202	cagagagattctgtgctttg	18	<i>H. sapiens</i>	54
99224	3	2881	tgagctgttaatgatgctaa	21	<i>H. sapiens</i>	55
99226	3	528	atccatcatctgatgtttct	23	<i>H. sapiens</i>	56
99227	3	1898	actgatcttctaagttcact	24	<i>H. sapiens</i>	57
99228	3	2849	catctccttgatcagctgaa	25	<i>H. sapiens</i>	58
99229	3	840	ctgttgataagagagctcgg	26	<i>H. sapiens</i>	59
99230	3	1581	accaacacaatgcagaagct	27	<i>H. sapiens</i>	60
99232	3	3144	caaagagcagattacctctg	29	<i>H. sapiens</i>	61
99233	3	1341	aaaatgaacttgaccagtgt	30	<i>H. sapiens</i>	62
99235	3	2119	gcaatgtggaaacctactg	32	<i>H. sapiens</i>	63
99237	3	1053	gtacattggaatatgctcat	34	<i>H. sapiens</i>	64
99238	3	536	tctgatgtttctgagagact	35	<i>H. sapiens</i>	65
99239	3	394	agaggatcccttggtgta	36	<i>H. sapiens</i>	66
99241	3	1619	aacctgaatagtctgtttaa	38	<i>H. sapiens</i>	67
99242	3	2960	ctggggcagtagactgaaga	39	<i>H. sapiens</i>	68
99244	3	1159	acgtttaaaacgagatcttg	41	<i>H. sapiens</i>	69
99246	3	2260	tgtccaggaaaatatacagc	43	<i>H. sapiens</i>	70
99248	3	2333	gctgattctgatggcttctc	45	<i>H. sapiens</i>	71
99249	3	1023	ctgcattctcaatcttgag	46	<i>H. sapiens</i>	72
99250	3	2620	taaggcagctcatgagaaac	47	<i>H. sapiens</i>	73

[0171] As these "preferred target regions" have been found by experimentation to be open to, and accessible for, hybridization with the antisense compounds of the present invention, one of skill in the art will recognize or be able to ascertain, using no more than routine experimentation, further embodiments of the invention that encompass other compounds that specifically hybridize to these sites and consequently inhibit the expression of kinesin-like 1.

#### **Example 16**

##### **Western blot analysis of kinesin-like 1 protein levels**

[0172] Western blot analysis (immunoblot analysis) is carried out using standard methods. Cells are harvested 16-20 h after oligonucleotide treatment, washed once with PBS, suspended in Laemmli buffer (100 ul/well), boiled for 5 minutes and loaded on a 16% SDS-PAGE gel. Gels are run for 1.5 hours at 150 V, and transferred to membrane for western blotting. Appropriate primary antibody directed to kinesin-like 1 is used, with a radiolabeled or fluorescently labeled secondary antibody directed against the primary antibody species. Bands are visualized using a PHOSPHORIMAGER™ (Molecular Dynamics, Sunnyvale CA).

#### **Example 17**

##### **Cell cycle assay and flow cytometry analysis**

[0173] The measurement of the DNA content of cells can provide a great deal of information about the cell cycle, and consequently the effect on the cell cycle of added stimuli (e.g. transfected genes or drug treatment). Therefore, in a further embodiment of the invention, antisense compounds were analyzed for their effects on the cell cycle (DNA content) by fluorescence-activated cell sorting (FACS) analysis in MCF-7, T47D and HMEC cells. This analysis is based on the principle that the DNA content of a cell changes through the progression of the cell cycle and that this change can be quantitated by staining the DNA and measuring the amount of stain over a period of time. Flow cytometry (FACS) is a means of measuring certain physical and chemical characteristics, such as the DNA content, of cells or particles as they travel in suspension one by one past a sensing point.

[0174] When cells reached 70% confluency, they were treated with antisense oligonucleotide (ISIS 183881, SEQ ID NO: 16) or a control oligonucleotide, ISIS 29848, a

20-mer random oligonucleotide (NNNNNNNNNNNNNNNNNNNN, wherein each N can be A, C, G or T; herein incorporated as SEQ ID NO: 74) as described in other examples herein. For cells grown in 96-well plates, wells were washed once with 100  $\mu$ L OPTI-MEM™-1 reduced-serum medium (Invitrogen Corporation, Carlsbad, CA) and then treated with 130  $\mu$ L of OPTI-MEM™-1 containing 3.75  $\mu$ g/mL LIPOFECTIN™, (Invitrogen Corporation, Carlsbad, CA) and the desired concentration of oligonucleotide. After 4-7 hours of treatment, the medium was replaced with fresh medium. Cells were harvested 16-24 hours after oligonucleotide treatment and the growth medium (including floating cells) were transferred to fluorescence-activated cell sorting (FACS) tubes. The remaining cells were detached from the plates with gentle tapping and were washed with 250  $\mu$ L PBS/5mM EDTA. Following the wash, 250  $\mu$ L trypsin was added to the cells and incubated at room temperature for 5 minutes. These cells were then added to the FACS tubes. Tubes were spun in a tabletop centrifuge at 2000 rpm for 5 minutes and the supernatant was decanted.

[0175] Cells were then washed with 2 ml PBS/5mM EDTA and the tubes were spun again at 2000 rpm for 5 minutes with the supernatant being decanted after centrifugation. Cells were then resuspended with 0.4 ml PBS/5mM EDTA and briefly vortexed. Following resuspension and vortexing, 1.6 mls cold ethanol was added while the tube was again gently vortexed.

[0176] Cells were stored at -20° C overnight. The following day, tubes were spun at 2000 rpm and the supernatant was decanted. Cells were then washed with 2 mls PBS/5mM EDTA and resuspended with 0.15 ml PI mix (100  $\mu$ g/ml propidium iodide, 1:200 RNase cocktail; Ambion, Inc. (Austin, TX), Catalog Number # 2286). Samples were then run on a flow cytometer and the data were analyzed via the ModFit™ algorithm (AMPL Software Pty Ltd, Turrumurra, Australia) to determine the distribution of cells in subG1, G1-, S- and G2/M-phases of mitosis. The percent of cells arrested in the G2/M phase of the cell cycle for each cell line is shown in Table 3. Data are compared to untreated controls (UTC) and the control antisense oligonucleotide, ISIS 29848. Data are an average of two assays.

Table 3a

**Percent Arrest in G2/M phase of the cell cycle by ISIS 183881**

	Percent G2/M Arrest		
Cell line	UTC	Control; ISIS 29848	ISIS 183881
MCF-7	7	8	23
T47D	15	20	45
HMEC	14	15	28

These data indicate that ISIS 183881 was able to arrest cancer cells in the G2/M phase of the cell cycle.

This experiment was repeated with the cancer cell lines; data are shown in Table 3b.

Table 3b

**Percent Arrest in G2/M phase of the cell cycle by ISIS 183881**

	Percent G2/M Arrest		
Cell line	UTC	Control; ISIS 29848	ISIS 183881
MCF-7	13	15	34
T47D	15	20	41

It was also demonstrated that this antisense compound had no effect on cell polyploidy.

These data are shown in Table 4.

Table 4

**Percent Polyploidy after treatment with ISIS 183881**

	Percent Polyploidy		
Cell line	UTC	Control; ISIS 29848	ISIS 183881
MCF-7	12	13	14
T47D	19	23	20
HMEC	3	4	5

These data indicate that the antisense compound, ISIS 183881 did not induce the production



of multiple nuclei, but in fact arrested cells in mitosis.

[0177] Treatment of T47D cells with ISIS 183891 also caused rounding of cells, which was not seen with a control oligonucleotide or in untreated controls.

#### **Example 18**

##### **Dose responsiveness and time course of the arrest of T47D cells in G2/M by treatment with antisense to kinesin-like 1**

[0178] T47D cells were cultured and treated with ISIS 183891 as described above, using oligonucleotide concentrations of 0, 50, 100, 150 and 200 nM. At these doses, the percentage of cells in G2/M was approximately 23%, 40%, 47%, 50% and 54%, respectively.

[0179] In a time course using 150 nM ISIS 183891, the percentage of T47D cells in G2/M was observed to increase from 20% at time 0 to 55% at 24 hours after treatment, 50% at 48 hours and 32% at 72 hours.

#### **Example 19**

##### **G2/M arrest by antisense knockdown of kinesin-like 1 compared to knockdown of other genes in breast cancer cell lines or normal breast cell lines**

[0180] Several breast cell lines were treated with an antisense inhibitor of kinesin-like 1 or with an antisense inhibitor of one of 19 other randomly selected cellular genes. In the MCF7 human breast cancer cell line, the percentage of cells in G2/M after treatment with antisense to kinesin-like 1 (ISIS 183881) was over triple the percentage of control-treated cells in G2M. In contrast, cells treated with antisense inhibitors of the other genes showed no increase or an increase of less than 1.3 fold.

[0181] In HMEC (normal human mammary epithelial) cells the percentage of cells in G2/M after treatment with antisense to kinesin-like 1 (ISIS 183881) was increased to approximately 1.5 fold the percentage of control-treated cells in G2M. In contrast, cells treated with antisense inhibitors of the other genes showed no increase or an increase of less than 1.3 fold.

[0182] In T47D human breast carcinoma cells, the percentage of cells in G2/M after treatment with antisense to kinesin-like 1 (ISIS 183881) was increased to approximately 2.1 fold the percentage of control-treated cells in G2M. In contrast, cells

treated with antisense inhibitors of the other genes showed no increase or an increase of less than 1.2 fold.

### Example 20

#### Expression of kinesin-like 1 in transformed vs. primary cultured cells

[0183] Relative levels of kinesin-like 1 RNA were determined by RT-PCR in 14 transformed human cell lines and 5 primary (non-transformed) human cell cultures. Relative kinesin-like RNA levels in each cell type were normalized to levels in T47D cells. Results are shown in Table 5.

**Table 5**  
**Relative kinesin-like 1 RNA levels in cultured cells**

Cell name	Cell type	Transformed or primary	Kinesin-like 1 RNA level (as % of levels in T47D cells)
T47D	Breast adenocarcinoma	Transformed	100%
T47Dp53	Breast adenocarcinoma	Transformed	38
MCF7	Breast carcinoma	Transformed	100
A549	Lung carcinoma	Transformed	125
769-P	Kidney epithelial carcinoma	Transformed	82
T24	Bladder carcinoma	Transformed	142
HepG2	Liver Carcinoma	Transformed	34
Hep3B	Hepatocellular carcinoma	Transformed	70
HeLa	Cervical carcinoma	Transformed	83
SK-OV-3	Ovarian carcinoma	Transformed	37
DU145	Prostate carcinoma	Transformed	131
PC3	Prostate cancer	Transformed	52
U87-MG	Glioblastoma	Transformed	92
Jurkat	T-cell leukemia	Transformed	130
Huvec	Normal vascular endothelium	Primary	80
HMEC	Normal mammary epithelium	Primary	20
PreD	Normal pre-adipocyte	Primary	20
D3	Normal differentiated adipocyte	Primary	1

Dendritic	Normal dendritic	Primary	undetectable
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**Example 21****Kinesin-like 1 protein expression in cultured cells**

[0184] Levels of kinesin-like 1 protein were measured in cultured cells by western blotting and normalized to GAPDH. Results are shown in Table 6 relative to kinesin-like 1 levels in T47D cells.

**Table 6**  
**Kinesin-like 1 protein levels in cultured cells**

Cell name	Cell type	Transformed or primary	Relative kinesin-like 1 protein levels
T47D	Breast adenocarcinoma	Transformed	100%
T47Dp53	Breast adenocarcinoma	Transformed	141
MCF7	Breast carcinoma	Transformed	141
U266	Multiple myeloma	Transformed	97
769-P	Kidney epithelial carcinoma	Transformed	58
T24	Bladder carcinoma	Transformed	151
Hep3B	Hepatocellular carcinoma	Transformed	69
HeLa	Cervical carcinoma	Transformed	73
SK-OV-3	Ovarian carcinoma	Transformed	61
DU145	Prostate carcinoma	Transformed	51
PC3	Prostate cancer	Transformed	107
U87-MG	Glioblastoma	Transformed	116
Huvec	Normal vascular endothelium	Primary	54

**Example 22****Antisense inhibition of kinesin-like 1 expression arrests many cell types in G2/M**

[0185] A panel of cell types were treated with ISIS 183891, an antisense inhibitor of kinesin-like 1, or with an unrelated control oligonucleotide, and the percentage of cells in G2/M was assayed, using methods described in previous examples. Results are shown in Table 7 as approximate percentage of cells in G2/M.

Table 7

**Antisense inhibition of kinesin-like 1 causes G2/M arrest**

Cell name	Cell type	% of cells in G2/M (control oligo)	% of cells in G2/M (ISIS 183891)
T47D	Breast adenocarcinoma	20	32
T47Dp53	Breast adenocarcinoma	13	32
MCF7	Breast carcinoma	14	25
MDA-MB231	Breast carcinoma	14	47
A549	Lung carcinoma	15	90
T24	Bladder carcinoma	15	32
DU145	Prostate carcinoma	16	32
PC3	Prostate carcinoma	17	91
MiaPaca	Pancreatic carcinoma	16	47
Panc1	Pancreatic carcinoma	18	52
HeLa	Cervical carcinoma	20	60
SK-OV-3	Ovarian carcinoma	27	68
U87-MG	Glioblastoma	16	42
Hep3B	Hepatocellular carcinoma	30	54
769-P	Kidney carcinoma	46	69
Huvec	Normal human vascular endothelium	16	47
HMEC	Normal mammary epithelium	31	51

**Example 23****Inhibition of kinesin-like 1 mRNA expression in MCF7 breast cancer cells is dose-dependent**

[0186] MCF7 cells were cultured as described in previous examples and treated with ISIS 183881 at concentrations of 30 nM and 100nM. At 30nM ISIS 183881, kinesin-like 1 expression as measured by RT-PCR was reduced by almost 80% compared to

untreated control. At 100 nM ISIS 183881, kinesin-like 1 expression was reduced by approximately 90% compared to untreated control. The IC<sub>50</sub> was 20 nM. In contrast, kinesin-like 1 in cells treated with an unrelated control oligonucleotide was not reduced by more than 10% at either concentration of oligonucleotide.

#### Example 24

##### Effect of kinesin-like 1 antisense oligonucleotides on kinesin-like 1 mRNA levels and G2/M arrest in T47D human breast carcinoma cells

[0187] The kinesin-like 1 antisense oligonucleotides ISIS 183881 and ISIS 183891 were tested for dose-dependent effects on kinesin-like 1 expression and G2/M arrest in T47D human breast carcinoma cells. The negative control oligonucleotide used, ISIS 335395 (CCAGGCCTTCTATTCAAG; SEQ ID NO: 75), is an 8-base mismatch of ISIS 183891.

[0188] Cells were treated with oligonucleotides for 24 hours at concentrations of 0, 0.5, 1, 5, 10, 25, 50 and 100 nM. Dose-dependent reduction in kinesin-like 1 mRNA was measured by RT-PCR and results are shown in Table 8.

**Table 8**

##### Antisense inhibition of kinesin-like 1 expression in T47D breast carcinoma cells

Oligonucleotide dose (nM) ↓	Percent inhibition after treatment with:		
	ISIS 335395	ISIS 183881	ISIS 183891
0	0	0%	0
0.5	34	14	12
1	30	30	21
5	30	20	41
10	28	24	46
25	14	42	53
50	13	43	61
100	20	40	75

Inhibition of kinesin-like 1 expression was dose dependent.

The percentage of cells in G2/M was also determined for these treated cells. Data are shown in Table 9.

**Table 9**  
**Percentage of T47D breast carcinoma cells**  
**cells in G2/M after inhibition of kinesin-like 1 expression**

Oligo dose (nM) ↓	Percent of cells in G2/M after treatment with:					
	ISIS 335395		ISIS 183881		ISIS 183891	
	24 hr	48 hr	24 hr	48 hr	24 hr	48 hr
0	13	30	13	30	13	30
25	13	31	20	32	26	43
50	14	31	21	39	32	53
100	16	30	28	48	34	54

#### **Example 25**

##### **Inhibition of kinesin-like 1 protein expression in T47D cells**

[0189] T47 cells were cultured as in previous examples. Cells were treated with ISIS 183891 at 200nM for 48 hours. Kinesin-like 1 protein levels were quantitated by western blot analysis using mouse anti-human Eg5 (kinesin-like 1) antibody (BD Biosciences Pharmingen, San Diego CA, catalog #611187) and normalized to G3PDH. Treatment with ISIS 183891 reduced kinesin-like 1 protein levels by 85%.

#### **Example 26**

##### **Kinesin-like 1 antisense oligonucleotide inhibits T47D cell proliferation**

[0190] T47D cells were cultured as in previous examples. Cells were treated with the kinesin-like 1 antisense oligonucleotide ISIS 183891 and an unrelated control oligonucleotide at 200 nM for 24, 48 or 72 hours. Results are shown in Table 10.

Table 10

**Antisense to kinesin-like 1 (ISIS 183891) inhibits T47D cell proliferation**  
(expressed in relative cell number)

Time ↓	Untreated control	Control oligonucleotide	ISIS 183891
24hr	50	60	30
48hr	85	100	28
72hr	220	200	30

**Example 27**

**Effect of kinesin-like 1 antisense oligonucleotides on kinesin-like 1 mRNA levels and G2/M arrest in MDA-MB231 human breast carcinoma cells**

[0191] The kinesin-like 1 antisense oligonucleotides ISIS 183881 and ISIS 183891 were tested for dose-dependent effects on kinesin-like 1 expression and G2/M arrest in MDA-MB231 human breast carcinoma cells. The negative control oligonucleotide used, ISIS 335395 (CCAGGCCTTCTATTCAAG; SEQ ID NO: 75), is an 8-base mismatch of ISIS 183891.

[0192] Cells were treated with oligonucleotides for 24 hours at concentrations of 0, 0.5, 1, 5, 10, 25, 50 and 100 nM. Dose-dependent reduction in kinesin-like 1 mRNA was measured by RT-PCR and results are shown in Table 11.

Table 11

**Antisense inhibition of kinesin-like 1 expression in MDA-MB231 breast carcinoma cells**

Oligonucleotide dose (nM) ↓	Percent inhibition after treatment with:		
	ISIS 335395	ISIS 183881	ISIS 183891
0	0	0	0
0.5	4	5	0
1	0	4	4
5	18	18	34

10	5	2	43
25	16	36	54
50	7	61	73
100	18	63	69

Inhibition of kinesin-like 1 expression was dose dependent.

The percentage of cells in G2/M was also determined for these treated cells. Data are shown in Table 12.

**Table 12**

**Percentage of MDA-MB231 breast carcinoma cells  
cells in G2/M after inhibition of kinesin-like 1 expression**

Oligo dose (nM) ↓	Percent of cells in G2/M after treatment with:					
	ISIS 335395		ISIS 183881		ISIS 183891	
	24 hr	48 hr	24 hr	48 hr	24 hr	48 hr
0	13	15	13	15	13	15
25	11	15	23	24	32	37
50	9	14	35	30	34	46
100	11	15	44	48	30	40

#### **Example 28**

**Effect of kinesin-like 1 antisense oligonucleotides on kinesin-like 1 mRNA levels and G2/M arrest in HeLa human cervical carcinoma cells**

[0193] The kinesin-like 1 antisense oligonucleotides ISIS 183881 and ISIS 183891 were tested for dose-dependent effects on kinesin-like 1 expression and G2/M arrest in HeLa human cervical carcinoma cells. The negative control oligonucleotide used, ISIS 335395 (CCAGGCCTTCTATTCAAG; SEQ ID NO: 75), is an 8-base mismatch of ISIS 183891.

[0194] Cells were treated with oligonucleotides for 24 hours at concentrations of 0, 0.5, 1, 5, 10, 25, 50 and 100 nM. Dose-dependent reduction in kinesin-like 1 mRNA was measured by RT-PCR and results are shown in Table 13.



**Table 13****Antisense inhibition of kinesin-like 1 expression in HeLa cervical carcinoma cells**

Oligonucleotide dose (nM) ↓	Percent inhibition after treatment with:		
	ISIS 335395	ISIS 183881	ISIS 183891
0	0	0	0
0.5	0	3	12
1	0	0	0
5	0	1	30
10	5	2	33
25	17	46	61
50	5	65	84
100	0	56	84

Inhibition of kinesin-like 1 expression was dose dependent.

The percentage of cells in G2/M was also determined for these treated cells. Data are shown in Table 14.

**Table 14**

**Percentage of HeLa cervical carcinoma cells  
cells in G2/M after inhibition of kinesin-like 1 expression**

Oligo dose (nM) ↓	Approx. percentage of cells in G2/M after treatment with:					
	ISIS 335395		ISIS 183881		ISIS 183891	
	24 hr	48 hr	24 hr	48 hr	24 hr	48 hr
0	17	15	17	15	17	15
25	17	16	16	14	56	39
50	18	17	23	16	70	67
100	16	17	48	33	68	68

**Example 29****Kinesin-like 1 expression in tumor and normal tissues from individual patients**

[0195] Kinesin-like 1 expression was compared between normal and tumor tissues from over 240 individuals using BD CLONTECH™ Cancer Profiling Array I (Palo Alto CA) according to manufacturer's instructions. This array contains matched pairs of cDNA

(normal and tumor, each pair from a single patient) spotted side by side on a nylon membrane. A  $^{32}\text{P}$ -labeled probe (nucleotides 1902-3152 of SEQ ID NO: 77) for kinesin-like 1 was hybridized to the array according to manufacturer's instructions.

Results are shown in tabular form in Table 15.

**Table 15**  
**Human kinesin-like 1 expression in tumor vs normal tissues**

Tumor type	# Sample Pairs	Detected in Normal Tissue		Detected in Tumor Tissue		>2 fold in Tumor	
		Number	Percent	Number	Percent	Number	Percent
Breast	53	25	47	41	77	26	49
Colon	38	27	71	34	89	10	26
Kidney	21	3	14	5	24	1	5
Lung	21	7	33	15	71	12	57
Ovary	16	6	38	15	94	9	56
Rectum	19	14	74	16	84	5	26
Stomach	28	15	54	22	79	11	39
Thyroid	6	4	67	4	67	1	17
Uterus	44	14	32	33	75	23	52

Thus it can be seen that kinesin-like 1 expression is increased twofold in approximately 25-60% of breast, colon, lung, ovary, rectum, stomach and uterus tumor samples, and also (to a lesser extent) in kidney and thyroid tumor samples.

### Example 30

#### Antisense inhibition of human kinesin-like 1 expression by additional chimeric phosphorothioate oligonucleotides having 2'-MOE wings and a deoxy gap

[0196] In accordance with the present invention, a series of oligonucleotides were designed to target different regions of the human kinesin-like 1 RNA, using published sequences (GenBank accession number NM\_004523.1, incorporated herein as SEQ ID NO: 3 and 4; a truncated portion of GenBank accession number NT\_030059, incorporated herein

as SEQ ID NO: 76; GenBank accession number NM\_004523.2, incorporated herein as SEQ ID NO: 77; GenBank accession number BL050421.1, incorporated herein as SEQ ID NO: 78; and GenBank accession number BX103943.1, incorporated herein as SEQ ID NO: 79). The oligonucleotides are shown in Table 16. "Target site" indicates the first (5'-most) nucleotide number on the particular target sequence to which the oligonucleotide binds. All compounds in Table 16 are chimeric oligonucleotides ("gapmers") 20 nucleotides in length, composed of a central "gap" region consisting of ten 2'-deoxynucleotides, which is flanked on both sides (5' and 3' directions) by five-nucleotide "wings". The wings are composed of 2'-methoxyethyl (2'-MOE) nucleotides. The internucleoside (backbone) linkages are phosphorothioate (P=S) throughout the oligonucleotide. All cytidine residues are 5-methylcytidines. The compounds were analyzed for their effect on human kinesin-like 1 mRNA levels by quantitative real-time PCR as described in other examples herein. Data are averages from two experiments in which T-24 cells were treated with the antisense oligonucleotides of the present invention. As noted, some of the compounds were designed to be fully complementary to more than one animal species (human, mouse, and/or rat).

Table 16

**Inhibition of human kinesin-like 1 mRNA levels by chimeric phosphorothioate oligonucleotides having 2'-MOE wings and a deoxy gap**

Isis No	Region	Target SEQ ID NO	Target site	Sequence	% inhib	SEQ ID NO	Species
183881	Coding	3	1753	atccaagtgctactgtagta	89	16	Human
183883	Coding	3	2202	caaagcacagaatctctctg	81	18	Human, Mouse
183891	Coding	3	840	ccgagctctcttatcaacag	86	26	Human
285688	Coding	3	212	gctccaaacaccatatcaaa	45	80	Human, Mouse
285689	Coding	3	217	tagatgctccaaacaccata	38	81	Human, Mouse
285694	Coding	3	936	tttagattctcgataaggaa	60	82	Human, Mouse
285695	Coding	3	941	gttagtttagattctcgata	73	83	Human, Mouse
285696	Coding	3	949	ggattctagtttagtttagat	43	84	Human, Mouse
285698	Coding	3	989	attatagatgttctgttacg	73	85	Human, Mouse
285699	Coding	3	995	gttgcaattatagatgttct	88	86	Human,

							Mouse
285700	Coding	3	1032	cagagtttctcaagattga	45	87	Human, Mouse
285701	Coding	3	1037	gtactcagagtttctcaag	75	88	Human, Mouse
285702	Coding	3	1042	ccaatgtactcagagtttcc	58	89	Human, Mouse
285703	Coding	3	1047	atattccaatgtactcagag	37	90	Human, Mouse
285704	Coding	3	1052	tgagcatattccaatgtact	73	91	Human, Mouse
285705	Coding	3	1122	ctccttaataagagcttttt	60	92	Human, Mouse
285706	Coding	3	1127	gtatactccttaataagagc	58	93	Human, Mouse
285708	Coding	3	1187	tacactccatttttctcacg	9	94	Human, Mouse
285712	Coding	3	1346	gatttacactgggtcaagttc	58	95	Human, Mouse
285713	Coding	3	1351	ggtcagatttacactgggtca	89	96	Human, Mouse
285714	Coding	3	1356	ttgcagggtcagatttacact	77	97	Human, Mouse
344870	Coding	3	67	tgcattctcaccaccacctgg	76	98	Human, Mouse
344871	Intron 1	76	10298	gaagtaaaagcaggtagatg	19	99	Human
344872	Intron 1	76	12002	acctgagttcatttttccca	70	100	Human
344873	Intron 9	76	28627	ccgtatactcctacacaaga	71	101	Human
344874	Intron 16	76	46149	aaaatgcaccaacattctt	73	102	Human
344875	Intron 17	76	51266	gaaatccatcagtcctagata	28	103	Human
344876	Intron20:Exon 21 junction	76	57643	catccacatcctaaaagaag	41	104	Human
344877	Intron 6a:Exon 22a junction	76	61939	ggatacaactagggttagat	50	105	Human
344878	5' UTR	77	13	tgcgtggcctggaggaccga	51	106	Human
344879	5' UTR	77	39	ggagtcctccctgggtactctc	22	107	Human
344880	Start codon	77	126	gccatgacgggtccccgccaa	69	108	Human
344881	Coding	3	79	aattaaatgggtctgcatctc	45	109	Human
344882	Coding	3	136	cttttcgtacaggatcacat	62	110	Human
344883	Coding	3	245	acacttcggtaaacaatcaat	25	111	Human, Mouse
344884	Coding	3	251	caaacaacacttcggtaaac	31	112	Human, Mouse

344885	Coding	3	256	ttggacaaacaacacttcgg	68	113	Human, Mouse
344886	Coding	3	281	tagcccataataacttcac	35	114	Human, Mouse
344887	Coding	3	286	aattatagcccataataact	9	115	Human, Mouse
344888	Coding	3	329	aaagttttccagtgccagt	78	116	Human, Mouse, Rat
344889	Coding	3	334	ttgtaaaagttttccagt	50	117	Human, Mouse, Rat
344890	Coding	3	346	ttcaccttccattgtaaaa	6	118	Human, Mouse, Rat
344891	Coding	3	351	tgacctttcaccttccattg	46	119	Human, Mouse, Rat
344892	Coding	3	356	ttaggtgacctttcaccttc	51	120	Human, Mouse, Rat
344893	Coding	3	361	cttcattaggtgacctttca	39	121	Human, Mouse, Rat
344894	Coding	3	405	acgtggaattataccagcca	93	122	Human, Rat
344895	Coding	3	428	ttctcaaaaatttgatgaag	22	123	Human, Mouse
344896	Coding	3	437	tcagtaagtttctcaaaaat	9	124	Human, Mouse, Rat
344897	Coding	3	442	cattatcagtaagtttctca	38	125	Human, Mouse, Rat
344898	Coding	3	662	gcagttgtccttttgcctgc	78	126	Human, Mouse
344899	Coding	3	758	acaagctcttctccatcaat	45	127	Human, Mouse, Rat
344900	Coding	3	763	ttttaacaagctcttctcca	76	128	Human, Mouse, Rat
344901	Coding	3	805	tgttttcacttctgcaaga	44	129	Human, Rat
344902	Coding	3	1218	actcatgactctaaaatttt	59	130	Human
344903	Coding	3	1306	actctgtaaccctattcagc	70	131	Human
344904	Coding	3	1628	tccatattattaaacagact	36	132	Human, Mouse
344905	Coding	3	1781	gacacattttctggaataga	69	133	Human, Mouse
344906	Coding	3	1876	tgagtacattaatcaattcc	41	134	Human
344907	Coding	3	2130	cttcaggcttcagttaggt	62	135	Human, Mouse
344908	Coding	3	2135	attgtcttcaggcttcagt	25	136	Human, Mouse
344909	Stop codon	3	3173	caagtgaattaaaggttgat	25	137	Human
344910	3' UTR	3	3598	aattcaactgaatttacagt	10	138	Human

344911	3' UTR	3	3641	caaagtgaactatagggatg	30	139	Human
344912	3' UTR	77	4125	taaaattctgactactgaaa	0	140	Human
344913	3' UTR	77	4180	ttgttgacagtgttttaga	48	141	Human
344914	3' UTR	77	4211	taaaggagggatacaactag	31	142	Human
344915	3' UTR	77	4351	agtcagatgtctgggtggc	61	143	Human
344916	3' UTR	77	4367	gtggcacagagccattagtc	68	144	Human
344917	3' UTR	77	4548	tcctaagggttaagatttga	47	145	Human
344918	3' UTR	77	4599	tgaacatctcaactccag	22	146	Human
344919	3' UTR	77	4651	gagcagaaaattattcttt	45	147	Human
344920	3' UTR	77	4670	tacacactaaactcatcgtg	56	148	Human
344921	3' UTR	77	4865	catggatttactgagggcag	53	149	Human
344922	3' UTR	77	4973	ttattaaccatggatttact	26	150	Human
344923	Coding; Exon 1a:Exon 20 junction	78	286	gggtgctgtaccaccacctgg	22	151	Human
344924	Intron 9	76	28230	aaagcctactaggttaatca	41	152	Human
344925	Intron 10	76	28736	tggaaattaactccatagcc	45	153	Human
344926	Coding; Exon 6:Exon 22a junction	79	542	agggatacaactagagtatg	14	154	Human

As shown in Table 16, SEQ ID NOs: 82, 83, 85, 86, 88,89, 91, 92, 93, 95, 96, 97, 98, 100, 101, 102, 108, 110, 113, 116, 122, 126, 128, 130, 131, 133, 135, 143, 144 and 148 gave at least 56% inhibition of kinesin-like 1 and are therefore preferred.

### Example 31

#### Antisense inhibition of mouse kinesin-like 1 expression by chimeric phosphorothioate oligonucleotides having 2'-MOE wings and a deoxy gap

[0197] A series of oligonucleotides were designed to target different regions of the mouse kinesin-like 1 RNA, using published sequences (GenBank accession number AJ223293.1, incorporated herein as SEQ ID NO: 155; and GenBank accession number BB658933.1, incorporated herein as SEQ ID NO: 156). The oligonucleotides are shown in Table 17. "Target site" indicates the first (5'-most) nucleotide number on the particular target sequence to which the oligonucleotide binds. All compounds in Table 17 are chimeric oligonucleotides ("gapmers") 20 nucleotides in length, composed of a central "gap" region consisting of ten 2'-deoxynucleotides, which is flanked on both sides (5' and

3' directions) by five-nucleotide "wings". The wings are composed of 2'-methoxyethyl (2'-MOE) nucleotides. The internucleoside (backbone) linkages are phosphorothioate (P=S) throughout the oligonucleotide. All cytidine residues are 5-methylcytidines. The compounds were analyzed for their effect on mouse kinesin-like 1 mRNA levels by quantitative real-time PCR as described in other examples herein. Data are averages from two experiments in which b.END cells were treated with the antisense oligonucleotides of the present invention. As noted, some of the compounds were designed to be fully complementary to more than one animal species (human, mouse, and/or rat).

Table 17

**Inhibition of mouse kinesin-like 1 mRNA levels by chimeric phosphorothioate oligonucleotides having 2'-MOE wings and a deoxy gap**

Isis No	Region	Target SEQ ID NO	Target site	Sequence	% inhib	SEQ ID NO	Species
285686	Coding	155	27	tccgtacactgacttctttc	66	157	Mouse
285687	Coding	155	32	tgcagtcctgacactgactt	75	158	Mouse
285688	Coding	155	88	gctccaaacaccatatcaaa	72	159	Human Mouse
285689	Coding	155	93	tagatgctccaaacaccata	70	160	Human Mouse
285690	Coding	155	677	attttcacttcctgcaagat	60	161	Mouse
285691	Coding	155	731	gttgatatttcagcttccc	75	162	Mouse
285692	Coding	155	744	tcaagagggattgggtgata	58	163	Mouse
285693	Coding	155	760	ataactcttcccagagtcaa	68	164	Mouse
285694	Coding	155	809	tttagattctcgataaggaa	64	165	Human Mouse
285695	Coding	155	814	gtagtttagattctcgata	72	166	Human Mouse
285696	Coding	155	822	ggattctagttagtttagat	61	167	Human Mouse
285697	Coding	155	834	gagaatcttgcaggattcta	67	168	Mouse
285698	Coding	155	862	attatagatgttctgtacg	49	169	Human Mouse
285699	Coding	155	868	gttgcaattatagatgttct	75	170	Human Mouse
285700	Coding	155	905	cagagtttctcaagattga	67	171	Human Mouse
285701	Coding	155	910	gtactcagagtttctcaag	78	172	Human Mouse
285702	Coding	155	915	ccaatgtactcagagtttcc	76	173	Human

							Mouse
285703	Coding	155	920	atattccaatgtactcagag	70	174	Human Mouse
285704	Coding	155	925	tgagcatattccaatgtact	70	175	Human Mouse
285705	Coding	155	995	ctccttaataagagctttt	60	176	Human Mouse
285706	Coding	155	1000	gtatactccttaataagagc	65	177	Human Mouse
285707	Coding	155	1032	caagatctcgcttcaaagc	76	178	Mouse
285708	Coding	155	1060	tacactccattttctcacg	75	179	Human Mouse
285709	Coding	155	1091	attcatggctctaaaacttt	49	180	Mouse
285710	Coding	155	1160	ctcctcctcaagaacagcga	74	181	Mouse
285711	Coding	155	1204	agttcgttcttactatccat	73	182	Mouse
285712	Coding	155	1219	gatttacactgggtcaagttc	66	183	Human Mouse
285713	Coding	155	1224	ggtcagatttacactgggtca	77	184	Human Mouse
285714	Coding	155	1229	ttgcaggctcagatttacact	78	185	Human Mouse
285715	Coding	155	1264	tgtttctgagtgggttcaag	67	186	Mouse
285716	Coding	155	1321	tccaaggctgaagagacata	59	187	Mouse
285717	Coding	155	1330	tcgggtctttccaaggctga	77	188	Mouse
285718	Coding	155	1356	tgctggccgtgtcatgcagt	75	189	Mouse
285719	Coding	155	1379	ttcttaaccgtgttaagca	74	190	Mouse
285720	Coding	155	1742	atcaatcaatccttcagaa	71	191	Mouse
285721	Coding	155	1818	tatttatgtcaagatggaa	58	192	Mouse
285722	Coding	155	1950	aagaaactgtgtttctcgg	66	193	Mouse
285723	Coding	155	1972	agctttgtgattcaaccaa	73	194	Mouse
285724	Coding	155	2085	catacttcttccaaagca	56	195	Mouse
285725	Coding	155	2139	tagacctccgctctgtattt	61	196	Mouse
285726	Coding	155	2208	cttgtaataatccatcagat	60	197	Mouse
285727	Coding	155	2224	ttaaagtgtctgagttcttg	61	198	Mouse
285728	Coding	155	2288	caggttgctgttgagtgaac	53	199	Mouse
285729	Coding	155	2295	cagtcctcaggttgctgttg	61	200	Mouse
285730	Coding	155	2374	aggcaggatgccactgatc	74	201	Mouse
285731	Coding	155	2412	actccattaaattctcaagt	71	202	Mouse
285732	Coding	155	2484	caacacgtgcgctctgttct	50	203	Mouse
285733	Coding	155	2496	tgtgctgggtcgcaacacgt	43	204	Mouse
285734	Coding	155	2599	aagcaattcagctttgttaa	67	205	Mouse
285735	Coding	155	2606	tttcagaaagcaattcagct	61	206	Mouse
285736	Coding	155	2643	gtgtcatacctgttgggata	55	207	Mouse
285737	Coding	155	2652	tcctctctggtgtcatacct	76	208	Mouse
285738	Coding	155	2683	ctcacaagtgtgttgata	76	209	Mouse
285739	Coding	155	2754	ctgagctgttttagcatcatt	67	210	Mouse
285740	Coding	155	2840	tgtctctggacttacaagtt	55	211	Mouse



285741	Coding	155	2852	gggtagttcagttgtctctg	31	212	Mouse
285742	Coding	155	2888	aaatggaagacctctgctgg	40	213	Mouse
285743	Coding	155	2895	gctggaaaaatggaagacct	56	214	Mouse
285744	Coding	155	3036	ctcagatcagctagagggtt	64	215	Mouse
285745	Coding	155	3041	taagcctcagatcagctaga	71	216	Mouse
285746	3' UTR	155	3064	gttgatttttaagatgaca	70	217	Mouse
285747	3' UTR	155	3152	agactttcagttcaactaca	79	218	Mouse
285748	3' UTR	155	3228	acacacacacatattcaatg	64	219	Mouse
285749	3' UTR	155	3272	atacttacttggtacagaag	42	220	Mouse
285750	3' UTR	155	3429	aaaagggagagcaggatcga	59	221	Mouse
285751	3' UTR	155	3500	ttccaggtaaaaccctgcgt	58	222	Mouse
285752	3' UTR	155	3702	agacttaagaccttttaag	48	223	Mouse
285753	3' UTR	155	3921	ctctctgcatacacttttag	62	224	Mouse
285754	3' UTR	155	3979	ctgtgccaaaaccacatcac	65	225	Mouse
285755	3' UTR	155	4016	tagtgagtccaagccagcc	59	226	Mouse
285756	3' UTR	155	4035	ggatgactgtcctgctgcat	73	227	Mouse
285757	3' UTR	155	4058	gtctgtattcccaggccttg	73	228	Mouse
285758	3' UTR	155	4175	agatcaggctggcctcgaaa	90	229	Mouse
285759	3' UTR	155	4258	ctctttgttacaaggtcta	73	230	Mouse
285760	3' UTR	155	4366	taattttattaaaataacg	0	231	Mouse
285761	5' UTR	156	223	tcctctttcttctcaaga	66	232	Mouse
285762	5' UTR	156	255	atctcaccaccacctggatg	64	233	Human Mouse
285763	5' UTR	156	301	actgagtggcattagcttt	66	234	Mouse

For mouse kinesin-like 1 the PCR primers were:

forward primer: GCTTCAAGTTCGGAGATCACTAAGA (SEQ ID NO: 235)

reverse primer: CGGAAGTCATCTGAGCAACAAA (SEQ ID NO: 236) and the PCR

probe was: FAM-AGAACAGAGCGCACGTGTTGCGA-TAMRA

(SEQ ID NO: 237) where FAM is the fluorescent dye and TAMRA is the quencher dye.

### Example 32

#### Mouse kinesin-like 1 antisense compounds reduce kinesin-like 1 mRNA in B16 melanoma cells

[0198] Mouse B16 melanoma cells (American Type Culture Collection, Manassas VA) were cultured in DMEM with 10% fetal bovine serum and penicillin/streptomycin. Cells were treated with ISIS 285714, 285717 and 285747 at 200nM for 4 hours in Opti-MEM. Kinesin-like 1 mRNA levels were measured by RT-PCR after 24 hours. ISIS 285714, 285717 and 285747 reduced kinesin-like 1 RNA levels by 78%, 80% and 85%, respectively.

**Example 33****Mouse kinesin-like 1 antisense compounds induce G2/M arrest in B16 melanoma cells**

[0199] Mouse B16 melanoma cells were treated with ISIS 285714, 285717 and 285747 and the percentage of cells in G2/M was measured as in previous examples. The percentage of cells in G2/M after treatment with Isis 285714, 285717 and 285747 was 22%, 18% and 19%, respectively after 48 hours and 34%, 43% and 31%, respectively, after 72 hours, whereas cells treated with unrelated control oligonucleotide had fewer cells in G2/M (20% of cells after 48 hr, 27% after 72 hr).

**Example 34****Antisense inhibitors of kinesin-like 1 are nontoxic in mice**

[0200] Male C57Bl6 mice (Jackson Labs) were dosed intraperitoneally with 200 ul of saline or 50 mg/kg of antisense oligonucleotide (ISIS 285714, ISIS 285717 or ISIS 285747) in 200 ul of saline, twice a week for a total of 5 injections. Twenty four hours after the last does, mice were sacrificed and serum and organs were harvested. Liver and spleen weights were not significantly increased in antisense-treated mice compared to saline treated mice. Serum AST and ALT (measures of liver toxicity) were also not significantly increased after antisense treatment.

**Example 35****Kinesin-like 1 expression in SV40 transgenic (HCC) mice**

[0201] An HCC mouse model (Taconic, Germantown NY) for hepatocellular carcinoma was used in which transgenic male mice express SV40 T-antigen (Tag) in their livers, which leads to spontaneous development of well-differentiated hepatocellular carcinoma (HCC) carcinomas. Expression of kinesin-like 1 in livers of wild type mice and HCC mice was measured using array blot analysis. Kinesin-like 1 expression in wild type mouse livers as very low, but was shown to be upregulated up to approximately 15 fold in the HCC mice, and even more (up to about 25 fold) as tumors developed.

**Example 36****The effect of antisense inhibition of kinesin-like 1 expression in SV40 transgenic (HCC) mice**

[0202] HCC mice were treated with ISIS 285714, 285717 or 285747 or with an unrelated control oligonucleotide. HCC and wild type mice were also treated with saline alone.

[0203] Kinesin-like 1 levels were virtually undetectable by RT-PCR in the wild type mice but easily detectable in the HCC mice as a result of the upregulation described in the previous example. Treatment of HCC mice with ISIS 285714, 285717 or 285747 decreased kinesin-like 1 mRNA levels by 72%, 62% and 90%, respectively. The unrelated control oligonucleotide caused only a 10% reduction in kinesin-like 1 mRNA in HCC mice.

**Example 37****Effect of antisense inhibitors of kinesin-like 1 on U87-MG human glioblastoma tumor cell xenografts in mice**

[0204] Nude mice were injected in the flank with approximately  $10^6$  U87-MG human glioblastoma cells. Mice were dosed with ISIS 183891, targeted to human kinesin-like 1, beginning the day after tumor inoculation and continuing every other day. Tumor volume was measured every few days beginning 10 days after inoculation. By day 22, tumor growth was detectably slower in the ISIS 183891-treated mice than in the control-treated mice and at the end of the study at day 30 after inoculation, tumor volume in ISIS 183891-treated mice was approximately  $250 \text{ mm}^3$ , compared to saline-treated and unrelated control oligonucleotide-treated mice in which tumor volume was approximately  $650 \text{ mm}^3$ .

**Example 38****Effect of antisense inhibitors of kinesin-like 1 on MDA-MB231 human breast tumor cell xenografts in mice**

[0205] Nude mice were inoculated with MDA-MB231 human breast cancer cells and were dosed with ISIS 183891, targeted to human kinesin-like 1, as described in the previous example.

[0206] By day 30, tumor growth was detectably slower in the ISIS 183891-treated mice than in the control-treated mice and at the end of the study at day 41 after inoculation,

tumor volume in ISIS 183891-treated mice was approximately 210 mm<sup>3</sup>, compared to saline-treated and unrelated control oligonucleotide-treated mice in which tumor volume was approximately 430 mm<sup>3</sup> and 380 mm<sup>3</sup>, respectively.

[0207] Together, these examples demonstrate that expression of kinesin-like 1 is upregulated in many cancer cell types, and that antisense inhibitors of kinesin-like 1 are effective for downregulating kinesin-like 1 expression and for arresting growth of a variety of cancer and tumor cell types.

### Example 39

#### Design and screening of duplexed antisense RNA compounds targeting kinesin-like 1

[0208] A series of nucleic acid duplexes comprising the antisense compounds of the present invention and their complements was designed to target kinesin-like 1 mRNA, using published sequence information (GenBank accession number NM\_004523.1, incorporated herein as SEQ ID NO: 3 and 4; GenBank accession number NT\_030059, incorporated herein as SEQ ID NO: 76; GenBank accession number NM\_004523.2, incorporated herein as SEQ ID NO: 77; GenBank accession number BL050421.1, incorporated herein as SEQ ID NO: 78; and GenBank accession number BX103943.1, incorporated herein as SEQ ID NO: 79). Each duplex is 20 nucleotides in length with blunt ends (no overhangs). The sequence of each antisense strand is listed in Table 18. The sense strand of the dsRNA was designed and synthesized as the complement of the antisense strand. All compounds in Table 18, as well as their complementary sense strands, are oligoribonucleotides, 20 nucleotides in length with phosphodiester internucleoside linkages (backbones) throughout. These sequences are shown to contain thymine (T) but one of skill in the art will appreciate that thymine (T) is generally replaced by uracil (U) in RNA sequences.

**Table 18**  
**dsRNAs targeted to human kinesin-like 1**

ISIS # of antisense strand	Corresponds to sequence of	Region	Target SEQ ID NO	Target site	Sequence	SEQ ID NO
347226	183881	Coding	3	1753	atccaagtgtactgtagta	16
347231	183883	Coding	3	2202	caaagcacagaatctcttg	18
347206	183891	Coding	3	840	ccgagctctcttatcaacag	26
347185	285688	Coding	3	212	gtccaaacaccatatcaaa	80
347186	285689	Coding	3	217	tagatgtctccaaacaccata	81
347207	285694	Coding	3	936	tttagattctcgataaggaa	82
347208	285695	Coding	3	941	gttagtttagattctcgata	83
347209	285696	Coding	3	949	ggattctagttagtttagat	84
347210	285698	Coding	3	989	attatagatgttctgtacg	85
347211	285699	Coding	3	995	gttgcaattatagatgttct	86
347212	285700	Coding	3	1032	cagagtttctcaagattga	87
347213	285701	Coding	3	1037	gtactcagagtttctcaag	88
347214	285702	Coding	3	1042	ccaatgtactcagagtttcc	89
347215	285703	Coding	3	1047	atattccaatgtactcagag	90
347216	285704	Coding	3	1052	tgagcatattccaatgtact	91
347217	285705	Coding	3	1122	ctccttaataagagcttttt	92
347218	285706	Coding	3	1127	gtatactccttaataagagc	93
347219	285708	Coding	3	1187	tacactccattttctcagc	94
347222	285712	Coding	3	1346	gatttacctgggtcaagttc	95
347223	285713	Coding	3	1351	ggtcagatttacctgggtca	96
347224	285714	Coding	3	1356	ttgcaggtcagatttacct	97
347172	344870	Coding	3	67	tgcattctaccaccacctgg	98
347173	344871	Intron 1	76	10298	gaagtaaaagcaggtagatg	99
347174	344872	Intron 1	76	12002	acctgagttcattttccca	100
347175	344873	Intron 9	76	28627	ccgtatactcctacacaaga	101
347176	344874	Intron 16	76	46149	aaaatgcaccaacattctt	102
347177	344875	Intron 17	76	51266	gaaatccatcagtctagata	103
347178	344876	Intron20:Exon 21 junction	76	57643	catccacatcctaaagaag	104
347179	344877	Intron 6a:Exon 22a junction	76	61939	ggatacaactagggttagat	105
347180	344878	5' UTR	77	13	tgcgtggcctggaggaccga	106
347181	344879	5' UTR	77	39	ggagtcicctgttactctc	107
347182	344880	Start codon	77	126	gccatgacgggtccccgcaa	108
347183	344881	Coding	3	79	aattaaatggctgcattctc	109
347184	344882	Coding	3	136	ctttcgtacaggatcacat	110
347187	344883	Coding	3	245	acacttcggtaaacatcaat	111
347188	344884	Coding	3	251	caaacaacacttcggtaaac	112

347189	344885	Coding	3	256	ttggacaaacaacacttcgg	113
347190	344886	Coding	3	281	tagcccataataacttcac	114
347191	344887	Coding	3	286	aattatagcccataataact	115
347192	344888	Coding	3	329	aaagtgtttccagtccagt	116
347193	344889	Coding	3	334	ttgtaaaagtgtttccagt	117
347194	344890	Coding	3	346	ttcaccttcattgtataaa	118
347195	344891	Coding	3	351	tgaccttcaccttcattg	119
347196	344892	Coding	3	356	ttaggtgaccttcaccttc	120
347197	344893	Coding	3	361	cttcattaggtgaccttca	121
347198	344894	Coding	3	405	acgtggaattataaccagcca	122
347199	344895	Coding	3	428	ttctcaaaaatttgatgaag	123
347200	344896	Coding	3	437	tcagtaagttctcaaaaat	124
347201	344897	Coding	3	442	cattatcagtaagtttctca	125
347202	344898	Coding	3	662	gcagttgtccttttgctgc	126
347203	344899	Coding	3	758	acaagctcttctccatcaat	127
347204	344900	Coding	3	763	ttttaacaagctcttctcca	128
347205	344901	Coding	3	805	tggtttcacttctctgaaga	129
347220	344902	Coding	3	1218	actcatgactctaaaatttt	130
347221	344903	Coding	3	1306	actctgtaacctattcagc	131
347225	344904	Coding	3	1628	tccatattattaacagact	132
347227	344905	Coding	3	1781	gacacattttctggaataga	133
347228	344906	Coding	3	1876	tgagtacattaatcaattcc	134
347220	344907	Coding	3	2130	cttcaggcttcaggttaggt	135
347230	344908	Coding	3	2135	attgtcttcagggtctcagt	136
347232	344909	Stop codon	3	3173	caagtgaattaaagggtgat	137
347233	344910	3' UTR	3	3598	aattcaactgaattacagt	138
347234	344911	3' UTR	3	3641	caaagtgaactatagggatg	139
347235	344912	3' UTR	77	4125	taaaattctgactactgaaa	140
347236	344913	3' UTR	77	4180	ttgttgacagtgatttaga	141
347237	344914	3' UTR	77	4211	taaaggagggtatacaactag	142
347238	344915	3' UTR	77	4351	agtcagatgtctgggtggtc	143
347239	344916	3' UTR	77	4367	gtggcacagagccattagtc	144
347240	344917	3' UTR	77	4548	tcctaagggttaagattga	145
347241	344918	3' UTR	77	4599	tgaaacatctcaactccag	146
347242	344919	3' UTR	77	4651	gagcagaaaattattcttt	147
347243	344920	3' UTR	77	4670	tacacactaaactcatcgtg	148
347244	344921	3' UTR	77	4865	catggatttactgagggcag	149
347245	344922	3' UTR	77	4973	ttattaacctggaatttact	150
347246	344923	Coding; Exon 1a:Exon 20 junction	78	286	ggtgtcgtaccaccacctgg	151
347247	344924	Intron 9	76	28230	aaagcctactaggttaatca	152
347248	344925	Intron 10	76	28736	tggaattaactccatagcc	153
347249	344926	Coding; Exon 6:Exon 22a junction	79	542	agggatacaactagagtatg	154

[0209] The compounds in Table 18 are tested for their effects on human kinesin-like 1 expression in A549 cells. A549 cells are treated with oligonucleotide mixed with LIPOFECTIN (Invitrogen Corporation, Carlsbad, CA) as described herein. Cells are treated with oligonucleotide for 4 hours and harvested an additional 16 hours later. Untreated cells serve as a control. Human kinesin-like 1 mRNA expression levels are quantitated by real-time PCR as described in other examples herein.